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ABSTRACT

This study investigated the availability of professional development opportunities for water quality control personnel in the midwest. The major objective of the study was to establish a listing of educational opportunities for the professional development of water quality control personnel and to compare these with the opportunities technicians identify as important. The results of the study indicate a significant lack of educational opportunities for professional development of water quality control personnel in the survey region. (Author/BE)

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PROFESSIONAL DEVELOPMENT FOR WATER QUALITY CONTROL PERSONNEL

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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The Ohio State University

1980

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CHAPTER I

INTRODUCTION

The last decade has seen sweeping changes in technology and legislation related to water quality control. Whereas man has heretofore struggled with what might be called a natural environment, he now faces an environment made artificial to the extent that he is introducing new hazards at an increasingly rapid rate. Personnel at all levels of operation and administration of public utilities are charged with solving water-related problems which are new to their experience (Cohen & Bregman, 1976; Grover, 1979; Schwaller, 1980). Employees need to understand and utilize the newest technologies to effectively control water quality. Managers and operators of these public utilities need to be highly qualified to achieve effective and economic operation of their facilities in accordance with current practices and standards. Personnel who are not adequately trained, or whose training is out of date, are unlikely to be able to carry out their job responsibilities at acceptable levels of competence or efficiency.

Since the supply of water is relatively constant and its use and reuse is increasing with industrial development and expanding population, the problems of controlling water pollution are becoming more complex (Lisack, 1969). It is no longer a simple matter of ridding our waters of domestic wastes. The management and operation of a

municipal wastewater treatment plant is a serious business and a highly critical service to the community. These facilities are responsible for guaranteeing that harmful wastes do not pollute our waters.

Recent emphasis on wastewater operations has focused on legislation affecting effluent discharges, construction grants for new and improved facilities, mandates for secondary or better treatment, development of new technologies, and an increasing concern over environmental quality (DeLong, 1979; Grover, 1979; Wubbena, 1979). Limited research has been done on the professional development needs of water quality control personnel to keep pace with these changes.

Need for the Study

According to the most recent figures, there are about 50,000 water supply facilities in the United States and about 40,000 wastewater treatment facilities (Water & Sewage Works, March 1979). About 80 percent of the facilities in both categories are one- or two-person operations. Unfortunately, many of the personnel involved in the operation, design, management and evaluation of wastewater treatment facilities do not have adequate training. Additionally, these individuals frequently do not have the time or opportunity to take advantage of the training if it is available. As a result, 70 percent of all water-related health problems are a result of the inadequate operation, design, management or evaluation of such facilities (Water & Sewage Works, March 1979).

The solutions to these water-related health problems depend upon dedicated, talented, and well-trained people. They must understand and intelligently use the latest technological tools available.

The U. S. Department of Labor (Occupational Outlook Quarterly, 1974) has identified several broad classifications of environmentally related jobs including: equipment operators, monitors, technicians, educators, and scientists. Personnel employed as scientists and educators hold positions as teachers, biologists, ecologists, economists, agronomists, writers, and related areas. The category of environmental monitors includes individuals employed as environmental inspectors, mechanical testers, food and drug inspectors, nuclear technicians, and lawyers.

Equipment operators and technicians include the personnel involved with powerplant, sanitary landfill, recycling, incinerator plant, and wastewater treatment operations. At the entry level, most technician jobs are open to workers with little or no previous training in the field (Olympus Research Corporation, n.d.). Wastewater treatment plant operations personnel help to recycle water and remove and dispose of municipal and industrial wastes and sewage. In their jobs they may operate specialized water pollution control equipment, take readings, recordings, and samplings of wastewater, and perform many other duties.

The following job descriptions are representative.

> Wastewater Treatment Plant Technician - Makes determinations of control treatment processes in the operation of wastewater treatment plants. Collects wastewater samples for routine and special analysis, adjusts dosages of chemical feeders, performs preventive maintenance tasks, observes safety requirements, services equipment and makes minor repairs to equipment. Maintains operational records. (Lisack, 1969)

> Wastewater Treatment Plant Supervisor - Coordinates activities of operations technicians, laborers, custodians, and other personnel. Prepares work schedules, analyzes instrument readings, adjusts plant processes. Prepares reports and maintains records. Inspects plant to determine efficiency of operation, instructs and directs operators, conducts training programs, and requisitions chemicals and supplies (U.S. EPA, Manpower Planning, 1972).

It has been recognized in the water quality control field and by regulating agencies that one way to provide qualified personnel to operate existing and future wastewater facilities is to make training materials for preparatory and continuing education available. The practice of certifying personnel in water and wastewater treatment has been in existence for about sixty years. All states have certification programs. Currently, 42 states have mandatory wastewater certification programs backed by legislative acts or state agency regulations. Certification in the other states is voluntary (Hadeed, 1978). In most states, certification or a license is granted for life. To date, only Iowa requires any continuing education or professional development activities for recertification or license renewal of engineers (Zimmerman, n.d.).

It would seem that there is a need for educational programs on the latest technologies for the updating and upgrading of personnel. Education institutions, employers, and professional organizations should be in the best position to provide these opportunities. There is, however, little research evidence to suggest which program areas are in greatest demand, or what learning experiences are most beneficial to the employee. By identifying the technological areas of importance, this study can contribute to the growth of professional development education

opportunities for water quality control personnel. A desired outcome of this study is to establish an empirical basis from which to substantiate future decisions concerning continuing education-professional development for water quality control personnel.

Scope of the Study

This investigation of educational opportunities for the professional development of water quality control personnel was approached in three phases. The first phase of the study undertook a review of recent literature, research and legislation relevant to water quality control. Obtaining information about available courses such as content and materials from program sponsors and information about education, job training and knowledge about professional development from currently employed water quality control personnel was the focus of phase two. Phase three involved the synthesis of this information to determine the important educational opportunities for water quality control personnel and projected recommendations for their professional development.

The problems of water quality control are global and influenced by many parameters such as population density, water resources, land use and industrialization. The U. S. Environmental Protection Agency, Region V, was selected for study because it represents a cross-section of these diverse parameters. Within the region there are rural areas of sparse population where the inhabitants engage in farming and other agricultural pursuits. There are also large industrialized urban centers with high population densities. In rural areas, wastewater treatment may be accomplished through the use of stabilization or

oxidation lagoons. Larger metropolitan areas, however, may require advanced treatment operations. In many cases, special technologies are required to handle large volumes of industrial effluents or problems inherent to a particular treatment system.

Climatic conditions within the region vary seasonally and yearly. Extremes in temperatures range from periods of bitter cold to hot dry spells. Average annual precipitation for the region is approximately thirty-five inches and provides the resource of water available for use. This region's water is obtained from lakes, rivers, upland reservoirs, and wells. After treatment, most wastewater is discharged into surface streams and rivers.

The Environmental Protection Agency estimates that of the 17,000 municipal wastewater treatment plants in the U. S. which provide more than stabilization pond treatment, fewer than 350 facilities have capabilities larger than ten million gallons per day. Sixty-five percent or more are actually less than one million gallons in capacity per day. Nationally, over 65% of the known non-pond systems are located in the Environmental Protection Agency Regions III, IV, and V (Municipal Sludge Management, 1976)

Since these regions contain approximately 11,000 wastewater treatment facilities, the control of water quality and the performance of plant operators is an important consideration. A recent study of Region V wastewater characteristics indicated substantial variations from standard engineering design text figures. Overall figures for flow were 40% higher, biological oxygen demand was 16% higher and suspended solids were 31% higher (Stoltenberg, 1980).

This region was targeted for study because it is representative of wastewater treatment operations currently in use. Treatment levels range from stabilization ponds through tertiary treatment with special processes for removal of particular chemicals. The mix of rural and urban centers provides for a diversity of administrative formats, from single municipality systems to large sanitary districts for several communities. Treatment for industrial effluents and differing hydraulic loads are influenced by the presence of agricultural and industrial regions. The information from this study should be applicable to the larger percentage of municipal wastewater treatment plants which provide more than stabilization pond treatment in the U. S.

Federal legislation controls two kinds of wastewater treatment operations - industrial and municipal, both integral parts of water quality control. Industrial operations have been under surveillance by the E.P.A. and in mid-1977, eighty-five percent of 4,000 major industries were in compliance with the effluent standards required by the Water Pollution Control Act (P.L. 92-500). However, according to the Environmental Protection Agency, only 30% of 13,000 municipal wastewater treatment plants were in compliance (DeLong, 1979).

This study is concerned only with the operations at municipal wastewater treatment facilities. Furthermore, the study is limited to the investigation of short courses, seminars, workshops, and conferences which help the currently employed professional by providing information for updating, upgrading, or certification. It does not address degree-oriented programs for future water quality control personnel since these degree-oriented programs are well documented.

Information regarding degree programs is available through school guidance counselors, professional organizations such as the Association of Environmental Engineering Professors and the American Academy for Environmental Engineers, and publications such as the Register of Environmental Engineering Graduate Programs.

Statement of the Objectives

Personnel involved with water quality control require educational opportunities for updating, upgrading, or certification. The objectives of this study are to:

1. identify these educational opportunities, their areas of emphasis and collect this information in a central location;

2. identify the areas of training of importance to water quality control personnel;

3. compile a personnel profile including information about educational attainment, length of employment, position classification, and knowledge about professional development opportunities;

4. compile a facility profile including information about period of construction, extent of renovation, treatment level offered, and administrative format.

Two major objectives of this study are to:

1. establish a listing of educational opportunities for the professional development of water quality control personnel and compare these with the opportunities technicians identify as important; and

2. determine what relationship the facility size, number of employees, hydraulic load, and treatment level has on participation in professional development opportunities.

Related tasks are:

1. To construct a questionnaire of items germane to the water quality control professional.

2. To ascertain, by use of the survey methodology, those educational opportunities which technicians deem most essential to their professional growth.

3. To ascertain, by use of the survey methodology, those educational opportunities which educators and organizations deem most essential to the professional growth of water quality control personnel.

Statement of the Hypotheses

The research hypotheses are:

There is a relationship between certification status and: 1) participation in, 2) familiarity with, and 3) importance attached to continuing education-professional development opportunities.

There is a relationship between educational attainment and: 1) participation in, 2) familiarity with, and 3) importance attached to continuing education-professional development opportunities.

There is a relationship between length of employment and: 1) participation in, 2) familiarity with, and 3) importance attached to continuing education-professional development opportunities.

There is a relationship between employment at differing treatment level facilities and 1) participation in, 2) familiarity with, and 3) importance attached to continuing education-professional development opportunities.

There is a relationship between employment classification and reasons for participating in continuing education-professional development opportunities.

Definition of Terms

The following words and phrases are defined as they will be used in this study.

Advanced Treatment - involves physical, biological, and chemical treatment of wastewater to remove contaminants or prepare water for reuse (Sundstrom, 1976).

Automatic Monitoring - the continuous, instrumented sensing of process variables, such as chlorine residual, dissolved oxygen, sludge density, and turbidity (U.S. EPA, Estimating Staffing, 1973).

Certification - the granting of a document by an institution to an individual for successful completion of an educational course of study and indicating that the individual is qualified to perform a given function (U.S. EPA, Manpower Planning, 1972).

Conference - a brief and intensive activity emphasizing practical experience and demonstration (Webster's 3rd).

Contaminant - a compound or element that is not normally present in the natural environment (Rohrer, 1972).

Continuing Education Unit - a measure of educational achievement earned through participation in continuing education programs (University of Wisconsin, 1979).

Courses - programs which focus on practical applications, methods, and specific skills (University of Wisconsin, 1979).

Educational Opportunity - activities applied to the development of information, concepts, intellectual abilities, and skills acquisition. These activities include workshops, short courses, seminars, and conferences (Schwaller, 1980).

Effluent - wastewater or other liquid which flows out of a basin, treatment process, or treatment plant (U.S. EPA, Start-up, 1973).

Environmental Protection Agency (EPA) - an agency of the U. S. government created in 1970 by Administrative Order and empowered with rulemaking and enforcement activities regarding the status of the environment. In particular, EPA administers a water pollution control program in accordance with the provisions of the Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500, (U.S. EPA, Manpower Development and Training Activities, 1972).

Hydraulic Load - a measure of the wastewater processed through a facility, calculated in millions of gallons per day (Sundstrom, 1976).

Influent - water, wastewater, or other liquid flowing into a reservoir, basin, treatment process, or treatment plant (U.S. EPA, Start-up, 1973).

National Environmental Training Association (NETA) - a private organization, founded in 1977, devoted to the promotion and advancement of vocational training and opportunities for operating technicians of environmental control facilities (Haller, 1979).

National Pollution Discharge Elimination System (NPDES) - a program established under the requirements of P.L. 92-500, directed by EPA, which requires all facilities to obtain a permit for the discharge

of effluents. The system is designed to meet the goal of the elimination of pollution discharges into navigable waters by 1985 (Trelease, 1974).

Operator - all persons directly associated with management and operation of wastewater collection and treatment facilities (U.S. EPA, Instructional Delivery Systems, 1979).

Physical-Chemical Treatment - processes alternative to the biological processes. The main physical-chemical processes are chemical coagulation, carbon adsorption, and filtration (Sundstrom, 1976).

Pollutant - any component that can adversely affect organisms or materials (Rohrer, 1972).

Pollution - the man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water (Trelease, 1974).

Pretreatment - processes to screen out coarse solids, reduce the size of solids, separate floating oils and equalize fluctuations in flow or concentration through short-term storage (Sundstrom, 1976).

Primary Treatment - involves the removal of suspended solids by settling or floating (Sundstrom, 1976).

Professional - one who works in any profession - implying training at the four-year college level (U.S. EPA, Manpower Planning, 1972).

Secondary Treatment - involves a biological process to remove organic matter through biochemical oxidation (Sundstrom, 1976).

Seminar - a meeting for giving and discussing information (Webster's 3rd).

Sewage - the waterborne waste materials carried off by sewers or drains (Woloschuk, 1974).

Sewers - a system of pipes that collect and deliver wastewater to treatment plants or receiving streams (Kerbec, 1971).

Stabilization Pond - a shallow body of water contained in an earthen basin, designed for the purpose of treating wastewater (U.S. EPA, Start-up, 1973).

Supervisor - an individual trained in a specialized field requiring a Bachelor's Degree or equivalent experience. In particular, wastewater treatment plant supervisors require a working knowledge of modern sanitation practices involved in sewage treatment (Lisack, 1969).

Technician - a person trained to perform complex or technical jobs requiring less than a Bachelor's Degree or its equivalent (U.S. EPA, Manpower Planning, 1972).

Training - the development of vocational skills (U.S. EPA, Manpower Planning, 1972).

Updating - the improvement of job skills (U.S. EPA, Manpower Planning, 1972).

Water Quality Criteria - 1) narrative or numerical limits on various kinds of pollutants (Rohrer, 1972); 2) the scientific requirements which a water source must meet in order to support a designated use (Sundstrom, 1976).

Water Quality Standards - 1) the enforceable tools for water quality management which contain requirements to which waste dischargers and other users must adhere (Rohrer, 1972); 2) requirements

which govern the quality of the water after the user is through with the water and before discharge back into the environment (Sundstrom, 1976).

Wastewater - effluent; the liquid waste consisting of various biological and chemical, both organic and inorganic, impurities (U.S. Department of Commerce, 1977).

Wastewater Facility - the structure and equipment necessary to treat wastewater from inlet to outfall and includes treatment, pumping, and other equipment (Koller, 1979).

Workshop - a program emphasizing free discussion, exchange of ideas, demonstration of methods and practical application of skills and principles (Webster's 3rd).

Overview of the Study

In order to carry out the stated objectives of this study, the following procedure was used:

1. Identify the focus.
2. Conduct a review of the literature.
3. Develop the research hypotheses.
4. Establish criteria for sample selection.
5. Select a sample of Region V businesses, organizations, agencies and educational institutions which satisfied the criteria.
6. Select a stratified random sample of municipal wastewater treatment facilities in Region V which satisfied the criteria.

7. Develop the questionnaires.
8. Revise the questionnaires.
9. Distribute questionnaires to the sample population.
10. Validate a random sample of respondents by personal contact.
11. Analyze responses and present the data.
12. Present conclusions and offer recommendations.

Chapter Summary

Chapter I has presented the introduction to the problem, the need for the study, the scope and objectives, the research hypotheses, definitions of terms, and an overview of the study.

This study seeks to discover educational opportunities for the professional development of water quality control personnel. The study employs a survey methodology to collect data from technicians, supervisors, and program sponsors as to their knowledge about and participation in continuing education-professional development opportunities.

The scope of the study involves surveying personnel at municipal wastewater treatment facilities, businesses, organizations, agencies, and educational institutions within the six state area comprised of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin, which constitute the U.S. EPA, Region V.

CHAPTER II

REVIEW OF THE LITERATURE AND SELECTED RESEARCH

Historical Perspective

The environmental movement of the 1970's did not come about as an overnight development of consciousness on the part of the American people. Instead, the concerns for the environment emerged from a concern for a quality of life, quality which was seen as being threatened.

There was, and in many cases still is, a myth of superabundance in this country. The natural resources of North America have been plentiful. They have been available for those who would conquer and subdue them. The prevailing attitude has been dominion over the land, water, and creatures (Udall, 1963).

Even with the historical prevalence of the superabundance attitude, pollution control requirements are of surprisingly ancient vintage. The first known statute (England) regulating pollution (air) was enacted over 700 years ago - in 1273 (Wark, 1976). Moreover, it appears that private lawsuits relating to pollution preceded this statute by several hundred years (U.S. EPA, Choosing Optimum Management Strategies, 1977).

During the first half of the United States' second century, attempts were made to control water pollution legislatively. Statutes were passed in the form of the Rivers and Harbors Act of 1899 and the Oil Pollution Act of 1924. These pieces of legislation were essentially ineffective and difficult to enforce. For years, the provisions of these

acts were applied only to discharges that threatened to impede navigation (Trelease, 1974). Over twenty years elapsed, 1924-1948, before attention was again given to water pollution problems. Federal assistance was finally offered in 1948 through the Water Pollution Control Act (P.L. 80-845). Passage of this legislation marked the entry of the United States into active participation in water quality control. This legislation stated that the prime responsibility for water pollution still rested with the states, but it provided for a supportive role through financial loans and an advisory role for federal authorities. Modifications to the legislation in 1956 strengthened the federal involvement by substituting a grant program for the earlier loan program. A portion of these funds were made available for the construction of municipal sewage treatment facilities.

The Water Quality Act of 1965 (P.L. 84-660) continued and expanded the policy to make monies available to the states for pollution control programs. For the first time, an organization (Water Pollution Control Advisory Board) charged solely with water pollution control was established and empowered to take an active role in formulating and enforcing standards of water quality.

Administration and enforcement of water pollution control was transferred through the President's Reorganization Plan No. 3, 1970, to the newly-formed Environmental Protection Agency. A more vigorous enforcement policy was attempted but complications prevented an effective enforcement program. The basis for this federal regulation of water pollution turned out to be paragraph 13 of the 1899 Rivers and Harbors Act (Trelease, 1974). This paragraph made it unlawful to:

"throw, discharge, or deposit any refuse of any kind or description, other than that flowing from streets and sewers in a liquid state, into navigable water, without a permit from the Secretary of the Army" (Rivers and Harbors Act, 1899). This paragraph provided the groundwork needed to establish the regulatory program administered by the Environmental Protection Agency.

On October 18, 1972, Congress established Public Law 92-500, The Federal Water Pollution Control Act Amendments of 1972. This Act essentially rewrote and consolidated the preceding laws in an effort to create a mechanism by which to attack and resolve the nation's water pollution plight. The 1972 Amendments established as a national goal, Section 101(a)(2), the elimination of pollution discharges into navigable waters by 1985. This is popularly called the zero discharge concept. Further amendments passed in December 1977, The Clean Water Act of 1977 (P.L. 95-217), provided guidelines for water pollution abatement programs to be carried out at the federal, state, and local levels.

In an effort to meet this goal, the Administrator of the Environmental Protection Agency was directed to establish a set of effluent limitations considered to be achieveable through in-plant changes, as well as end-of-pipe wastewater treatment. To help meet these effluent limitations, two basic methods of in-plant control were identified (U.S. EPA, Pollution Abatement, 1977):

1. plant and equipment design technology; and
2. training of personnel; complete and comprehensive for everyone involved in the operation of the facility.

Technology's rapid evolution is due primarily to new national policies and goals toward improved water quality which are expressed as federal and state water pollution control regulations. The ability to meet these requirements in many instances is dependent upon the development of new technologies or refinement of those which have been practiced for many years in the water quality control field.

Concomitant with plant and equipment design advancement, however, is the professional growth of facility personnel. As early as 1972, the Environmental Protection Agency recognized that "as changes in water quality standards call for more reliability in the performance of wastewater treatment plants, not only will additional manpower be needed, but the qualifications of many of those currently employed will have to be updated" (U.S. EPA, Manpower Planning, 1972).

Even with the earlier recognition, W. C. Anderson (1979) reports: "The importance of wastewater treatment plant operators and good operation and maintenance has gone unrecognized for many years. Good design can never make up for imcompetent operators" (Water & Sewage Works, May 1979).

Water Quality Control Legislation

Pollutants operate in total disregard of political boundaries, largely because the media in which many of them are carried are similarly unmindful of man-made lines on a map. Major rivers and their tributary systems flow through numerous political jurisdictions and waterborne pollutants can be the simultaneous concern of any number of these units.

The concepts that underlie the federal efforts in water pollution control have evolved from commercial considerations, through public health concerns, to water resources management. This trend has reflected increasing sophistication in understanding the effects of water pollution. Water pollution is the "natural" effluent of an industrial society, but it is acceptable only to the extent that the levels of pollution remain low enough so as not to hamper alternative uses of the water or destroy the aquatic ecosystem (Rohrer, 1972).

Responsibility for providing public water and sewage services has traditionally rested with the local units of government. In the U.S., the first public water supply programs were established in Boston as early as 1652 but it was more than 200 years later that sewage treatment works were constructed. The first trickle filter was used in 1892 in Massachusetts at the Lawrence Experiment Station.

Federal activity in water pollution control (Figure 1) has evolved over a period of approximately 100 years and has been divided by Rohrer into several periods (The Environmental Crisis, 1972).

These periods are described by Rohrer as: the years of Indecision, 1880 - 1948; the years of Incrementalism, 1948 - 1956; the years of Stalemate, 1956 - 1960; the years of Action, 1960 - 1966; and the years of Expansion, 1967 - present.

Although Rohrer utilizes these periods in defending his argument, the attachment of labels seems arbitrary, as the concern for water pollution control has met with the obstacles of all public concerns. Only when problems arise, or a call to action is demanded by a constituency, is a resolution promulgated.

1880

1899 - The Rivers and Harbors Act of 1899

1900

1910

1912 - Public Health Service Act of 1912

1920

1924 - Oil Pollution Act of 1924

1930

1940

1948 - Federal Water Pollution Control Act (P.L. 80-845)

1950

1956 - Federal Water Pollution Control Act Amendments (P.L. 84-660)

1960

1961 - Federal Water Pollution Control Act Amendments (P.L. 87-88)

1965 - Water Quality Act (P.L. 89-234)

1966 - Clean Water Restoration Act (P.L. 89-753)

1970 - Water Quality Improvement Act (P.L. 91-224)

1972 - Federal Water Pollution Control Act Amendments (P.L. 92-500)

1977 - Clean Water Act (P.L. 95-217)

1980

FIGURE 1

IMPORTANT LEGISLATION IN WATER QUALITY CONTROL, 1880-1980

During the years 1880 - 1948, there was indecision about the federal role in the management of the nation's resources. Water was no exception. For this period, the national government's responsibility for water quality was defined by three Acts: The Rivers and Harbors Act of 1899, forbidding the discharge or deposit of materials into waterways that would be hazardous to navigation; The Public Health Service Act of 1912, which contained provisions authorizing investigations of water pollution related to the diseases and impairments of man; and the Oil Pollution Act of 1924, forbidding oil discharges into coastal waters.

Several unsuccessful efforts were undertaken by Congress in the 1930's and 1940's to enact comprehensive Federal water pollution control legislation. These efforts were aimed at encouraging research related to water pollution, or for financing state, local, or industrial anti-pollution measures.

These efforts culminated with the passage of the Federal Water Pollution Control Act (P.L. 80-845) in 1948. This legislation set the precedent for federal responsibility. Congress recognized the need for federal research and technical assistance to states and municipalities on a wide variety of issues related to water quality. However, the Act was considered experimental and subject to change on the basis of experience with its operation (Rohrer, 1972). In the final analysis, the Act was a compromise measure, but clearly stated that the prime responsibility for water pollution control still rested with the states.

Amendments passed in 1956 (P.L. 84-660) strengthened and made permanent the 1948 legislation. The most significant aspect of the 1956

modifications was the substitution, for the earlier loan program, of a grant program to provide money for the construction of municipal sewage treatment works.

By the early 1960's, a substantial section of the populace had become aware of the gravity of the water pollution problem. The overwhelming majority of states were failing to live up to their responsibilities in pollution control (Cooley, 1970). In 1961, the Federal Water Pollution Control Act Amendments (P.L. 87-88) were passed. This was a step in curbing pollution problems by expanding the federal jurisdiction to include both interstate and navigable waters.

Nineteen sixty-five represented a milestone in Federal conservation legislation with the passage of the Water Quality Act (P.L. 89-234). It not only continued and expanded the policy established by earlier congressional action to make monies available to the states for pollution control programs but also broke important new ground. The purpose of this Act was to enhance the quality and value of the nation's water resources and to establish a national policy for the prevention, control, and abatement of water pollution.

The Federal Water Quality Act (P.L. 89-234) was concerned with domestic sewerage, synthetic organic chemicals, mineral by-products of industrial processes, oil spills, pesticide and fertilizer runoff from agricultural land, and thermal pollution.

Additionally, this Act established, for the first time at the Federal level, the Water Pollution Control Advisory Board which was charged with coordinating water pollution control efforts. With this

Act, the Federal government was empowered to take an active role in formulating and enforcing standards of water quality.

Passage of the Clean Water Restoration Act of 1966 (P.L. 89-753) provided increased grants for construction and research and encouraged the development of comprehensive water quality programs for entire river basins. Additionally, a legal and institutional framework for combating water pollution was firmly established.

Prior to the mid-1960's, there was no substantial environmental movement. There was, however, an increase in the introduction of legislation addressing environmental issues in the late 1960's. This trend is now a permanent part of the political value system at the federal, state, and local levels (DeLong, 1979).

Enactment of the Water Quality Improvement Act in 1970 (P.L. 91-224) provided further support of water quality control, specifically as it related to the design, operation, or maintenance of wastewater treatment facilities.

On October 18, 1972, Congress established P.L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. This Act essentially rewrote and consolidated the preceding laws in an effort to create a mechanism by which to attack and resolve the nation's water pollution plight.

Three categories of water pollution sources were identified. Each category—existing sources, new or modified sources, and sources of toxic pollutants, whether existing or new—was subject to a different method of regulation.

The objective of the Act was to restore and maintain the chemical, physical, and biological integrity of the nation's waters. To accomplish this goal, the Amendments established machinery for long-range planning and waste management by state governments and area-wide agencies. They also provided for careful planning of individual wastewater treatment facilities by municipalities and industrial dischargers. They expanded and redirected the research, development, and demonstration activities of the Environmental Protection Agency and established procedures for the issuance of permits for the ocean discharge of pollutants and for dredging and filling.

Consistent with the provisions of the Act, it was also declared that:

1. It is the national goal that the discharge of pollutants into navigable water be eliminated by 1985;
2. An interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1982; and
3. By July 1, 1977, all publicly-owned wastewater treatment plants must maintain secondary treatment of sewage.

This long awaited attack against water pollution was an ambitious undertaking. A regulatory structure had been identified but technology, economics, and manpower requirements were lagging behind the mandates outlined (Council on Environmental Quality, 1977). Additionally, many of the statutes were taken before the judiciary for clarification or explanation. On the whole, the goals of the legislation were upheld in

the courts but, by mid-1977, only 30 percent of municipal sewage treatment plants were meeting the interim deadline requirements (Council on Environmental Quality, 1977).

Congress responded by passing the Water Pollution Control Act Amendments of 1977, also known as the Clean Water Act (P.L. 95-217). This legislation did not lessen the requirements to be met in curbing water pollution. It did, however, extend the timeline for compliance.

Even with passage of P.L. 95-217, there is still much to be done to meet the abatement of water pollution. A timeline has been established. Criteria and standards have been identified. Money and technical support are available. Now, a pressing problem facing the water pollution control field is the recruitment, employment, training and retention of a skilled and dedicated workforce (Everts, 1964; Pipes, 1974; Sherrard and Sherrard, 1979).

Professional Development Legislation

The group of individuals who historically have solved water pollution problems have been identified as either sanitary engineers or public health engineers. Originally, they were concerned with reducing the high human death rates due to water pollution. Once the solution to the public health problems of water pollution had been developed, circa 1920, and implemented on a national scale, circa 1940, these engineers turned to protection of aquatic life and preservation of the quality of receiving water bodies as a water resource as rationales for their activities (Pipes, 1974).

As changes in the technology of wastewater treatment occur and as changes in water quality standards call for more reliability in the performance of wastewater treatment plants, not only is additional manpower needed but the qualifications of many of those currently employed need to be updated (U.S. EPA, Estimating Staffing, 1973).

A reservoir of trained and efficient manpower is the key to meeting responsibilities under P.L. 92-500 and to continue environmental improvement (U.S. EPA, Instructional Delivery System, 1979). This manpower cannot be developed haphazardly.

Although the specific concern for continuing education for wastewater personnel is a relatively recent development, Figure 2 illustrates that the promotion of education, professional development, and vocational training has a broader historical base (The Chronicle of Higher Education, 1979).

As early as 1867, the Federal government established the Department of Education to collect and disseminate information on education in the states and territories through the Department of Education Act (14 STAT 434). These beginnings provided a base from which additional educational concerns could be manifested.

The need for an organized program of trade-related education was recognized in the early years of the 20th century as indicated by the enactment of three pieces of legislation. The Smith-Hughes Act, 1917 (P.L. 64-347), provided grants for trade, industry, and agricultural education below the college level. In 1918, the Vocational Rehabilitation Act provided grants for job training of World War I veterans, and the Smith-Bankhead Act of 1920 authorized grants to states for

1880

1890

1900

1910
- Smith-Hughes Act (1917)
- Vocational Rehabilitation Act (1918)
- Smith-Bankhead Act (1920)

1920

1930

1940
- George-Barder Act (P.L. 79-586)

1950

1960
- Area Redevelopment Act (P.L. 87-27)
- Vocational Education Act (P.L. 88-210)
- Economic Opportunity Act (P.L. 88-452)
- Higher Education Act (P.L. 89-329)

1970
- Adult Education Act (P.L. 89-750)
- Vocational Education Amendments (P.L. 90-576)
- Comprehensive Employment and Training Act (P.L. 93-203)

1980 - Educational Amendments (P.L. 94-482)

FIGURE 2

IMPORTANT LEGISLATION IN PROFESSIONAL DEVELOPMENT EDUCATION, 1880-1980

vocational rehabilitation programs. These Acts responded to the needs which surrounded the postwar years and supplied the foundation for the development of vocational education.

Federal support was again expanded in 1946 with the George-Barder Act (P.L. 79-586), also called the Vocational Education Act. As before, this legislation was responsive to the social-environmental conditions evident in a postwar period.

It was not until the 1960's that attention was again focused on vocational and continuing education. During this period, six pieces of legislation were enacted. All of the Acts—The Area Redevelopment Act (P.L. 87-27), The Vocational Education Act (P.L. 88-210), The Adult Education Act (P.L.89-750), The Economic Opportunity Act (P.L. 88-452), The Higher Education Act (P.L. 89-239), and the Vocational Education Amendments (P.L. 90-576)—provided financial assistance to support vocational education agencies, residential vocational schools, research and training in vocational education, continuing education, cooperative education, and job training.

Of special importance to the water quality control profession was the Vocational Education Act of 1963 (P.L. 88-210) and its Amendments of 1968 (P.L. 90-576). These Acts emphasized assistance to the individual in preparing for employment and keeping up-to-date with the knowledge and skills needed by the job market.

The Carnegie Foundation for the Advancement of Teaching (1974) recognized that in all professional fields, careful and sustained attention needed to be given to adaptation of educational programs to the advancement of knowledge and technological change, and to society's

changing problems and needs. In particular, they stressed that continuing education opportunities be created for persons throughout their active careers through regular daytime classes, nighttime classes, summer courses, and special short-term programs.

There was not only a push for vocational, technical and continuing education programs within the traditional education community during the 1960's, but also within a variety of professional fields. The water pollution control field was no exception. Specific mandates for Training Grants were included in The Water Pollution Control Act Amendments of 1961 (P.L. 87-88), The Water Quality Act of 1965 (P.L. 89-234), The Clean Water Restoration Act of 1966 (P.L. 89-753), and The Water Quality Act of 1970 (P.L. 91-224).

The objectives of these grants were to expand and improve training and education as to the causes, control, and prevention of water pollution. They were further designed to increase the number of professional and technical manpower in this field. Section 5 (g) (1) of the 1970 Water Quality Act specifically provided for the financial support of instructor training, advanced waste treatment training, and training programs to upgrade plant personnel.

The Water Pollution Control Act Amendments of 1972 (P.L. 92-500) and further Amendments passed in 1977 (P.L. 95-217) provide guidelines for water pollution abatement programs carried out at the federal, state, and local levels. The importance of training activities is reflected in Section 104(g), Subsections (1) and (3). They call for providing an adequate supply of trained personnel by financing pilot programs of manpower development and training of persons in or entering

into the field of water pollution control and making grants available to establish and maintain fellowships for public and private agencies and institutions to use for the training of staff members in the causes, prevention, reduction, and elimination of pollution.

Even with this emphasis on training, the Environmental Protection Agency has determined that performance continues to be poor at municipal wastewater treatment facilities, resulting from the following four factors: operator's inability to properly assess system operations for efficient process control; improper technical guidance; inadequate operation and maintenance manuals; and inadequate operator training (Benjes and Owen, 1979).

At present, most states have done relatively little either to assess or to meet their needs in the pollution control workforce. Efforts to develop and implement operator training programs have usually been carried out on a local basis. The immediate objective of operator certification has guided these developmental efforts, rather than the long term goal of improved plant performance (U.S. EPA, Instructional Delivery System, 1979).

To meet current and proposed water pollution standards, it is often necessary to use newer treatment operations and to improve the efficiency of conventional processes. Since technology in the water quality control field is evolving rapidly, a system that imparts the necessary knowledge and skills, provides a means of evaluating competence, motivates learning and promotes professional growth is needed for maximum operator effectiveness.

Professional Development Directions

> "At best we are only just beginning to grasp the concept that collection, transportation, treatment, and distribution of water followed by its re-collection, re-transportations, and re-treatment, and release after it has been given a burden of wastes, constitute but a single aspect of water use by a community." (American Sanitary Engineering Intersociety Board, 1960)

Many of the problems of environmental disease had been solved, but the Board recognized that the needs for environmental control had changed. The growing complexity in the water quality control field required a corresponding increase and expansion in the role of the wastewater treatment plant operator. These technicians, in general, are involved in the application of knowledge and theories and frequently must analyze or solve problems using a variety of methods and equipment (Olympus Research Corporation, n.d.).

This concern about the changing environmental quality is an outgrowth of sanitary engineering, which originally developed in response to the need for safe public water supplies and for the disposal of liquid and solid wastes. Individuals filling the positions were trained in sanitary engineering and approached environmental control by engineering means (American Sanitary Engineering Intersociety Board, 1960).

As early as 1944, the Engineers Council for Professional Development appointed a subcommittee to investigate standards for technical education. They defined engineering technology as the set of skills closest to the engineer which require application of scientific and engineering principles in support of engineering activities.

The varied functions of the sanitary engineer in public health work necessitated additional education beyond that ordinarily acquired

by basic training in engineering. In its 1955 Report, the American Public Health Association indicated that the successful performance of a sanitary engineer in his profession requires an intimate and working knowledge of the physical, chemical, biological, and engineering sciences upon which the sanitary control of the environment is made and the ability to identify, evaluate, and explain in terms of a public health implication those environmental factors that will promote and protect health, or those that are capable of injuring health (The American Sanitary Engineering Board, 1960).

Although a need for technical education and expansion of sanitary engineering education had been expressed, it was not until 1962 that the American Society for Engineering Education (Final Report) reported that the potential impact of a technician shortage had induced national, state, and local legislation to supply funds for the expansion of some levels of technical education. They further reported that the effect of the legislation was difficult to assess, as many states were still in the planning stages and the focus was not on the education of personnel but on the construction of new wastewater treatment facilities.

A 1963 survey by the Conference of State Sanitary Engineers disclosed that the backlog of municipal waste treatment needs involved 5,800 communities affecting some 35 million persons (Erickson, 1964). Even with this focus on facilities, there was a concern for the education and continuing professional development to meet the technological changes taking place. The American Society for Engineering Education (ASEE, Future Directions, 1975) reported that the engineering of social systems requires greater consideration of human values and

attitudes and the characteristics of societal institutions, and that these emphases were not yet reflected by changes in engineering education.

Because of the natural time lag inherent in any educational process, if the demand changes, the production of individuals to suit the previous demand will continue for some time. To compensate for this educational lag, engineers have turned to continuing education as a means to stay up-to-date. This continuing education includes everything from formal courses to individual readings sponsored by academic institutions, professional societies, companies, and governmental units.

A study by the National Society of Professional Engineers in 1965 indicated that 67% of its members were taking technical courses. An American Society for Engineering Education study in the same year showed management and communications to be the most preferred subjects among its study group (ASEE, Future Directions, 1975).

As a result of the increased concern for the consideration of total environmental factors, during the mid-1960's, the World Health Organization spoke out for a revision of training programs for the traditional type sanitary-public health-engineer with a view to the education and training of the environmental health engineer of the future (WHO, Technical Report Series, No. 376, 1967). The World Health Organization further indicated that as man becomes increasingly aware of his responsibilities as custodian of the environment, the need for engineers specialized in environmental health increases.

Changes did occur. In 1971-1972, the Department of Labor initiated the Technology Utilization Project, which sent engineers back to

college for concentrated short-term education to prepare them for new careers (Kinn, 1973). A major recommendation from this program called for short-term supplementary education to prepare professionals for transition to new careers.

The American Society of Civil Engineers in 1974 called for the education and training of technologists and technicians to assist sanitary engineers in water pollution control (Pipes, 1974). They further indicated that with the shortage of appropriately educated sanitary engineers, a major national effort by academic institutions, not only in undergraduate environmental engineering and graduate sanitary engineering but also in continuing education for practicing engineers, was required. It became apparent that attaining the goals of water pollution control would require many more engineers, other professionals, and support personnel, and these people would need, on the average, a higher level of education than had been the case previously.

The Environmental Protection Agency also stressed the development of human resources to enable them to make the greatest possible contribution to the achievement of the national goals of environmental quality (U.S. EPA, Manpower Planning, 1972). In an attempt to coordinate and strengthen education and certification efforts, the Association of Boards of Certification proposed in 1972 a standard examination system for classification of water and wastewater facilities and personnel. Even so, many problems were still identified with the certification programs (Association of Boards of Certification, 1976). A survey report conducted by the Association of Boards of Certification in July 1976 revealed that the planning and development

of training in many states was not being conducted on a comprehensive basis with all the parties involved. Some of the problems that were recognized included: unavailability of training for operators in remote areas; difficulties in securing qualified instructors and financing; too much adherence to tradition; and college and vocational school course development which was often misguided, inappropriate, or failed to meet the operator's needs (Association of Boards of Certification, 1976).

In the Eighth Annual Report (1977), the President's Council on Environmental Quality indicated that many local governments had neither the trained manpower nor the financial resources for proper operation and maintenance of sewage treatment facilities. Treatment plants were found to be deficient in trained staff, budget, controls over industrial wastes, laboratory testing controls, design, and equipment. The report also indicated that, at best, only one-third of the municipal wastewater facilities would comply with the secondary treatment requirements of the Federal Water Pollution Control Act Amendments (P.L. 92-500) (Council on Environmental Quality, 1977).

Although the specific inclusion of provisions for training of water quality control personnel in environmental legislation prompted some development and implementation of training for water quality control personnel, problems still existed. Some training courses for required skills were incorporated at the larger metropolitan facilities but these courses were not assembled in an orderly way to enable corresponding training materials to be developed easily (Wubbena, 1979).

The Association of State Sanitary Engineers undertook a project in 1978 to determine the types of courses provided or planned for public water supply personnel and any training aids used in these courses. The results showed a wide variety of training programs, but they were specialized to a particular geographical region or operational procedure. Although this study dealt more directly with water supply operations, an area thought to be more advanced than wastewater treatment, the data indicated that no existing or proposed state water supply training program could be called truly comprehensive. Training development and management had been of a piecemeal nature and few programs were designed to assist trainees in advancing their careers (Conference Report, State Sanitary Engineers, 1978).

On-the-job training is the most commonly used training method at wastewater treatment plants. The success of this type of program has been good, although the quality of training can vary significantly from facility to facility (Sherrard and Sherrard, 1979). The operators of wastewater facilities in small communities often have a wide range of responsibilities and many restrictions on their capacity to take advantage of training opportunities (Wubbena, 1979). Large plants are in the best position to achieve a high level of operator training because they have the money and facilities to get the job done (Water and Sewage Works, 1979).

Even so, the administrative units of wastewater utilities lack awareness of training needs and lend only token support to program development and participation. Also, the absence of a recognized outline of what the operator needs to know, based on established acceptable

criteria for the industry, has prevented those involved in operator training from working together (Wubbena, 1979).

Little research evidence exists regarding educational needs of water quality control personnel to keep them up-to-date. The efforts of the Environmental Protection Agency have been concentrated on facility construction and effluent standards of the treatment processes. Other thrusts have been directed to the participation in and effect of continuing education; however, these were mostly addressed to engineers, with little attention given to the technician.

Middlebrooks (Battelle, 1979) examined manpower and retraining needs for water pollution control. A substantial need for short-term training was identified. The need was based upon data indicating that educational institutions provided inadequate training in the specialized technologies appropriate to water pollution control and there were significant differences between existing and needed skill levels (Battelle, 1979). There has not been a verification of what operators and technicians as a group need to know to efficiently operate their facilities (Wubbena, 1979).

Only a few small educational projects, conducted on a limited scale, have been initiated around the country. Examples include: the training programs in basic treatment and specialized operation procedures initiated by the Detroit Metropolitan Sanitary District (Water & Sewage Works, 1978) for its personnel; a demonstration project initiated by the Rivanna Water and Sewer Authority, Virginia, to train youth for jobs in the water industry (Blair, 1979); and operator training through Project Optimize in Illinois, which addressed operation and

maintenance training for operators at municipal facilities and resulted in a substantial improvement in facility operation as a result of the program (U.S. EPA, Instructional Delivery System, 1979). The Environmental Protection Agency reported in 1979 that most states had done relatively little either to assess or to meet their needs in the pollution control workforce (U.S. EPA, Supply of Professional Manpower, 1979).

Interest and activity in training programs is just beginning to occur. More and more, education and training are becoming an important part of American business and industry (McQuigg, 1980). The fastest growing demands for courses are those dealing with the application of engineering technology to health-related occupations, facilities and equipment, and those dealing with energy conservation (Edwards, 1979). Educational opportunities for self-study and participation in workshops, seminars, and short courses are vital to the professional performance of water quality control personnel (Edwards, 1979).

To help meet these needs, several projects are currently underway. The Environmental Protection Agency, Region VIII, is financing trained-operator expeditions to wastewater facilities in need of instruction.

Charles County Community College, Maryland, in late 1979 surveyed operators, supervisors, and laboratory technicians who had completed one or more of the courses offered at the College. One hundred percent of the respondents indicated that they would be interested in participating in additional courses regarding the National Pollution Discharge Elimination System or specific technology courses patterned after the

Environmental Protection Agency courses sponsored by the National Training and Operational Technology Center (Engel, 1980).

Other surveys underway include the NEED survey undertaken by the National Environmental Training Association (1979). This survey seeks to identify and construct a profile of instructors and materials utilized in water quality control training activities within the Environmental Protection Agency, Region V. Information has been collected but a final report has not yet been released (Haller, 1980).

Another study by the Water Pollution Control Federation and the Joint Training Coordinating Committee is scheduled for release in 1980. This project was undertaken to develop a systematic method of evaluating materials used in training water and wastewater utilities personnel (Water Pollution Control Federation, 1980). It is intended as a reference resource for individuals responsible for providing training to water and wastewater utility personnel.

Even with this variety of activity, little is being done in the profession to identify the educational needs for updating or upgrading, as expressed by the personnel responsible for the facility operation. Training for the most part is too general, and plant-specific training is practically non-existent (Grover, 1979).

A study which describes the situation existing in Region V was conducted in June 1979 by the Region V Office of Manpower Planning. The information was obtained through telephone contacts with state personnel involved in operator training. The results indicate that only Michigan has made an attempt to survey training needs throughout the state. The other states indicated there was no established system for

determining training needs. The study also indicated that there are no requirements for continuing education once certification is achieved and each state has identified a number of unmet training needs. Although there are some variations, these identified areas deal with the development of operator support at the administrative level, maintenance of facility and equipment, treatment technology, operations analysis, and promotion of continuing education (Kosik, 1979).

Most of American industry has learned that investment in technical and skills training is as important as plant investment. It does little good to invest in computers, tools, and other sophisticated devices unless a skilled workforce is available to operate and maintain them. People must be trained so that they develop new skills, up-grade existing skills, and keep ahead of numerous changes that are part of our advancing scientific knowledge (Schwaller, 1980).

CHAPTER III

THE DESIGN OF THE STUDY

In the preceding chapters, the purpose of the study was introduced, the questions and hypotheses were proposed, and pertinent literature and research were reviewed. This chapter records the specific methods and procedures developed and used by the investigator to collect the data.

Selection of Sample Population

The U.S. Environmental Protection Agency, National Training and Operational Technology Center, Cincinnati, Ohio, offers professional development courses which address the problems of water and wastewater treatment and water quality control in general. These courses are well received. In fact, requests for enrollment far exceed available space. Additionally, many individuals desiring training are unable to participate in these courses as time, location, and cost do not allow them to be away from their jobs for the duration of the courses.

In an effort to alleviate the unequal distribution of courses and participants (Figure 3) as well as promote professional development for water quality control personnel, the National Training and Operational Technology Center is desirous of pinpointing educational opportunities at locations other than its facility.

U.S. EPA REGION	NUMBER OF PARTICIPANTS	PERCENT
I	24	3.4
II	47	6.7
III	142	20.5
IV	136	19.6
V	170[1]	24.5
VI	39	5.3
VII	40	5.7
VIII	36	5.2
IX	20	2.8
X	14	2.0
OTHER[3]	24	3.4
TOTAL	692	100.0[2]

[1](55%) of this number were participants from Ohio.
[2]Actual total less, due to rounding.
[3]Areas outside the United States.

FIGURE 3

REGIONAL DISTRIBUTION OF PARTICIPANTS FOR 1978-1979
NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER COURSES

Although it is recognized that water quality control is a national concern, for the purposes of this study, the region comprising the six states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin was targeted for investigation. This area is also designated as Region V within the U.S. Environmental Protection Agency structure. (Figure 4)

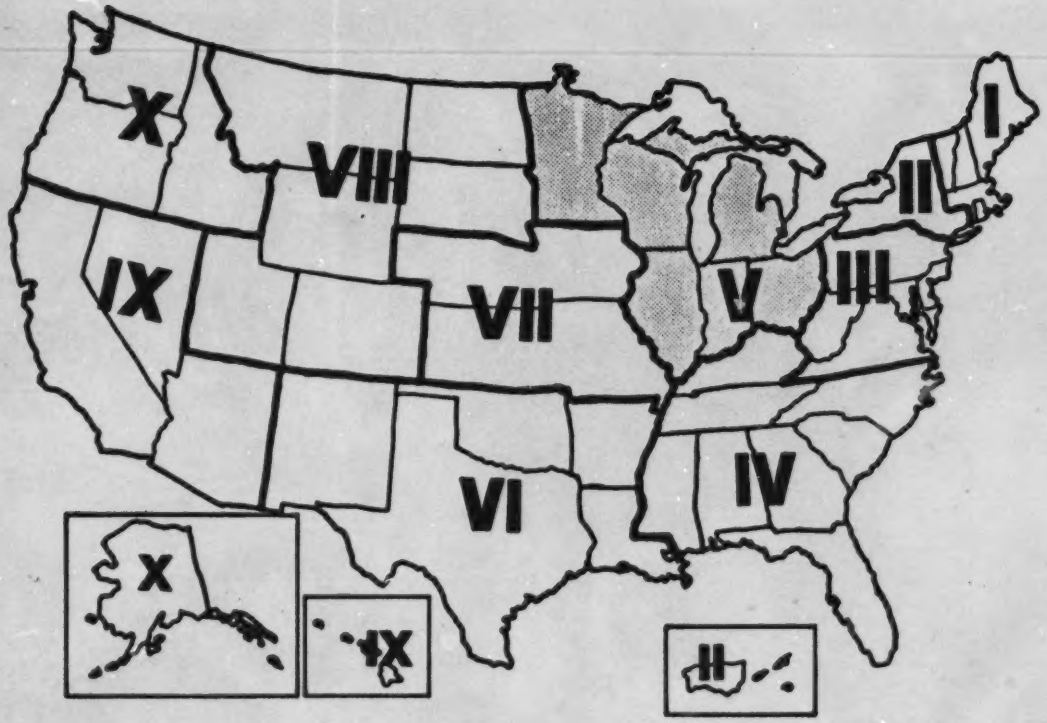


FIGURE 4, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONS

An important consideration of this study was to survey a variety of professional development opportunities thus the sample included organizations, businesses, agencies, and educational institutions concerned with water quality control. In selecting the sample to be surveyed, the following criteria were established.

For educational institutions:

1. they must be located within the study area;
2. they must be an accredited institution by a nationally recognized accrediting agency or appropriate professional association; and
3. they must offer at least a two-year Associate Degree Program.

Five hundred sixty-nine institutions in the study area, listed in the Education Directory, Colleges and Universities, 1978-79, were compared against the criteria established. Those which offered only theology, business, or other specialized programs were omitted from consideration. For four-year institutions, those which offered programs related to water quality control such as engineering or public health were selected over institutions which only offered liberal arts, music, or teaching degrees. All institutions which met the criteria were selected. A sample of 351 two- and four-year institutions was selected (Table 1) to receive the Water Quality Control Education Program Questionnaire (Appendix B).

TABLE 1

SAMPLE EDUCATION INSTITUTIONS IN STUDY AREA

STATE	TWO-YEAR INSTITUTIONS	FOUR-YEAR INSTITUTIONS	TOTAL
ILLINOIS	40	51	91
INDIANA	2	39	41
MICHIGAN	31	31	62
MINNESOTA	6	37	43
OHIO	22	54	76
WISCONSIN	14	24	38
TOTAL	115	236	351

Criteria used for the selection of agencies, organizations and businesses were:

1. they must be headquartered within the study area; and,
2. they have been identified as having some responsibility for water quality control within a state or the region; or
3. they are involved with a product or service directly related to water quality control.

Selection of agencies, organizations and businesses was completed by comparing those listed in the 1979 Environmental Yearbook & Product Reference Guide against the criteria established. All those which met the criteria were selected. One hundred and thirty-one agencies, organizations, and businesses were selected to receive the Water Quality Control Education Programs Questionnaire (Table 2).

TABLE 2

SAMPLE ORGANIZATIONS, AGENCIES, AND BUSINESSES IN STUDY AREA

STATE	AGENCY	BUSINESS	ORGANIZATION	TOTAL
ILLINOIS	5	29	5	39
INDIANA	2	2	2	6
MICHIGAN	4	12	2	18
MINNESOTA	4	5	1	10
OHIO	3	29	6	38
WISCONSIN	3	12	5	20
TOTAL	21	89	21	131

For both samples, a population of 482 businesses, organizations, agencies and education institutions was selected to receive the Water Quality Control Education Programs Questionnaire (Table 3).

TABLE 3

SAMPLE POPULATION TO RECEIVE THE
WATER QUALITY CONTROL EDUCATION PROGRAMS QUESTIONNAIRE

STATE	AGENCIES AND ORGANIZATIONS	EDUCATION INSTITUTIONS	TOTAL
ILLINOIS	39	91	130
INDIANA	6	41	47
MICHIGAN	18	62	80
MINNESOTA	10	43	53
OHIO	38	76	114
WISCONSIN	20	38	58
TOTAL	131	351	482

A purpose of this study is the identification of educational opportunities for the updating or upgrading of water quality control personnel. Since it is important to determine whether or not the existing opportunities are utilized by the professional and what content areas if any are underemphasized, a representative sample of these personnel was chosen to be surveyed. Water quality control personnel currently employed at municipal wastewater treatment facilities were targeted.

Selection was based on municipal population as provided by the 1970 U.S. census. Five population categories were identified for possible sampling, i.e.:

1. municipalities with a population less than 5,000
2. municipalities with a population greater than 5,000 but less than 25,000
3. municipalities with a population greater than 25,000 but less than 50,000
4. municipalities with a population greater than 50,000 but less than 100,000
5. municipalities with a population greater than 100,000.

The municipalities with a population less than 5,000 were dropped from the study in an attempt to sample a more representative segment of wastewater treatment plant operations and personnel. The remaining municipalities within each state were listed in alphabetical order within the appropriate population category, assigned a number, and a random sample was selected. Table 4 shows the number of municipalities

per population category for each of the states in the study area. Because of the unequal distribution of municipalities within the population categories, a sliding scale was employed for selection of the municipalities to be surveyed.

1. 10% of the municipalities with a population between 5,000 and 25,000
2. 50% of the municipalities with a population between 25,000 and 50,000
3. 75% of the municipalities with a population between 50,000 and 100,000
4. 100% of the municipalities with a population greater than 100,000.

A study population of 213 municipalities was selected from the population of 899 municipalities of 5,000 or more inhabitants within the study area (Table 4).

The geographical distribution of the municipalities surveyed is shown on the maps in Figures 8 through 13 in Appendix A.

Development of the Questionnaires

Construction of the survey instruments was undertaken in the latter part of 1979. Information for possible inclusion in the Water Quality Control Education Programs Questionnaire was solicited from several areas. First, the files of courses at the National Training and Operational Technology Center (NTOTC) and other course sponsors were investigated to determine representative areas of training, potential

TABLE 4

POPULATION AND SAMPLE FOR U.S. ENVIRONMENTAL PROTECTION AGENCY REGION V STUDY AREA

STATE	TOTAL MUNICIPALITIES GREATER THAN 5,000	MUNICIPALITIES PER POPULATION CATEGORY				MUNICIPALITIES SELECTED PER POPULATION CATEGORY				TOTAL MUNICIPALITIES SELECTED FOR STUDY
		A_1	B_1	C_1	D_1	A_2	B_2	C_2	D_2	
ILLINOIS	242	177	46	16	3	18	23	12	3	56
INDIANA	93	71	12	4	6	8	6	3	6	23
MICHIGAN	140	93	26	13	8	10	13	10	8	41
MINNESOTA	91	69	18	2	2	7	9	2	2	20
OHIO	243	196	27	12	8	20	14	9	8	51
WISCONSIN	90	68	13	7	2	7	7	6	2	22
TOTAL	899	674	142	54	29	70	72	42	29	213

A_1 - Population between 5,000 and 25,000.

B_1 - Population between 25,000 and 50,000.

C_1 - Population between 50,000 and 100,000.

D_1 - Population greater than 100,000.

A_2 - equals 10% of A_1

B_2 - equals 50% of B_1

C_2 - equals 75% of C_1

D_2 - equals 100% of D_1

participant characteristics, course structure, content, and instructional approaches, and geographical distributions.

Second, personnel involved with the training programs offered at the NTOTC facility were consulted. They were asked to provide comments regarding what information would be most useful to them in developing and conducting future educational opportunities for water quality control personnel. Third, professional journals, publications, and program bulletins related to continuing education and professional development were reviewed for advertised training opportunities. Initial review was done of those publications on file at NTOTC. Selection of additional publications was based on their relationship to water quality control. Sample journals surveyed include: Journal Water Pollution Control Federation, Water & Sewage Works, and the American Water Works Association Journal. Publications included: Guide to Continuing Education (Technological Advancement Centers, Inc.), Continuing Engineering Education Bulletin: Short Courses (George Washington University), and The Digester (Illinois EPA).

From the information collected in this initial review, several areas were identified to be addressed. While degree-oriented programs are important in meeting future requirements for water quality control, they do not necessarily address the needs of the professional currently employed in the field (Hadeed, 1978; Grover, 1979; Zimmerman, n.d.). For this reason, the first emphasis of the survey would be on short courses, seminars, workshops, and conferences designed to assist personnel with updating, upgrading, or certification. These activities

usually focus on free discussion, exchange of ideas, demonstration of methods and practical application of skills and principles.

The second emphasis of this study was targeted to those educational opportunities which are offered on a regular basis, structured around a planned format concerned with professional development and related to the certification, updating, or upgrading of personnel in water quality control. Access to courses which fulfilled the above stipulations should be beneficial to facility personnel in understanding and meeting the requirements for certification and the demands imposed by new technology and legislative mandates.

In addition to collecting the above information regarding professional development-continuing education courses and their availability, a description of the program sponsor and the content, format, and instructional methods of the program was desired. For this reason, questions were included on the survey instrument to secure such supportive information. These areas included: a program description; an indication of the course format, duration, and availability; costs, materials, and limitations; and, an official contact for additional information. Figure 5 provides an illustration of these areas and the questions associated with each.

In order to acquaint the professionals desiring additional training with the programs which might be most responsive to their needs, it was necessary to identify the educational opportunities and to survey the professionals for an expression of their needs. With this in mind, development of the Water Quality Control Personnel Questionnaire was

undertaken (Appendix C). The questionnaire is divided into three sections:

1. Selected demographic data was collected regarding the respondent. The supervisor and a technician/operator at the municipal wastewater facility were asked to provide information about their educational experience, length of employment in the profession, certification status, salary range, and membership in professional organizations.
2. The familiarity with and importance attached to education, training, and professional development was assessed.
3. Supervisors were asked to provide data about the physical plant including size of facility, treatment level offered, hydraulic load, number of employees, administrative format, and items of a similar nature.

Figure 6 provides an illustration of these three areas and the associated questions.

Draft copies of the questionnaires were assembled and distributed to members of the reading committee and personnel at the National Training and Operational Technology Center. The instruments were revised after receipt of their suggested modifications. In January 1980, the questionnaires and a synopsis of the study were submitted to a panel of 15 professionals for review and comment. Individuals on the review panel were selected on the basis of their involvement with the study, recommendations from project sponsors, or their expressed

INFORMATION AREAS	QUESTIONS ADDRESSING AREA
Program Description	6, 10, 11, 18
Format, Duration, Availability	2, 3, 4, 5, 17, 19, 20
Cost, Materials, Limitations	1, 7, 8, 9, 12, 13, 14, 15, 16, 21
Organization, Contact	22, 23

FIGURE 5

ITEM DISTRIBUTION OF
WATER QUALITY CONTROL EDUCATION PROGRAMS QUESTIONNAIRE

INFORMATION AREAS	QUESTIONS
Facility	II-13, III-1, III-2, III-3, III-4, III-5, III-6, III-7, III-8, III-9, III-10, III-11, III-12
Demographic	I-1, I-2, I-3, I-4, I-5, I-6, I-7, I-8, II-9, II-10
Perceptions	II-11, II-12, II-14, II-15, II-16

FIGURE 6

ITEM DISTRIBUTION OF
WATER QUALITY CONTROL PERSONNEL QUESTIONNAIRE

interest in the project. When the deadline for response had been reached, only 30% of the panel members had returned their materials. Several attempts were made to contact the nonrespondents by phone for their input. The individuals (7) returning the materials provided suggestions and minor modifications which were helpful in eliminating ambiguous questions and more directly addressing the problem areas. Those individuals (6) contacted over the phone expressed general agreement with the instruments as they were constructed and provided no suggestions for modification.

Two areas of concern were addressed repeatedly by the panel members. The first was a concern for a differentiation between professional and paraprofessional (Figure 7). It was stressed that a hierarchy exists within the profession and that the individuals holding a Bachelor's Degree or above and who are registered engineers are considered professionals. It was generally agreed that these individuals hold the administrative, management, or supervisory positions at the facilities. The operator/technician is generally considered to be the paraprofessional and usually has education only to the Associate Degree level, or sufficient years of employment experience to compensate for a lower educational level (American Society of Civil Engineers, 1974).

Another comment frequently received from panel members addressed the use or nonuse of continuing education units (CEU) for participation in courses. Although continuing education units are normally awarded on a standard basis, one unit per ten contact hours (Council on the Continuing Education Unit, 1979), not all course sponsors, i.e.

EDUCATIONAL LEVEL	JOB LEVEL			
	PARAPROFESSIONAL		PROFESSIONAL	
	OPERATOR	TECHNICIAN	SCIENTISTS	ENGINEER
HIGH SCHOOL	X			
ASSOCIATE DEGREE		X		
BACHELOR DEGREE			X	?
MASTERS DEGREE			X	X
DOCTORAL DEGREE			X	X

*American Society of Civil Engineers, 1974.

FIGURE 7

WATER QUALITY CONTROL PERSONNEL:
RELATION OF EDUCATION LEVEL TO JOB LEVEL*

businesses, agencies, or organizations, meet the accreditation requirements to make tham available to participants. There is also a concern among professional organizations that a standard procedure be established for assigning and granting continuing education credits. It is equally important that these units be applied in some standard fashion to certification, recertification, or licensing requirements.

Obtaining the Data

Taking into account the concerns expressed about professional-paraprofessional, the use of continuing education units and mechanical modifications, the final revisions to the questionnaires were made in late January 1980. On February 1, 1980, the questionnaires were sent out in a bulk mailing to the sample populations as indicated in Table 3 and Table 4 and summarized in Table 5.

On March 13, 1980, the questionnaires which had been returned were tabulated. Areas in which there were high percentages of non-response were analyzed and follow-up letters and additional questionnaires were distributed in an attempt to increase the percentage return rate. Questionnaires were again tabulated after the final cut-off date, April 25, 1980. The use of follow-up letters increased the total percentage return from 51.7 to 66.6.

In an attempt to validate the information received in response to the Water Quality Control Education Programs Questionnaire, randomly selected course sponsors within each state were selected and contacted. Selection was made from the respondents indicating that they offered educational opportunities which met the criteria established.

TABLE 5

SAMPLE POPULATION RECEIVING SURVEY QUESTIONNAIRES

STATE	WATER QUALITY CONTROL EDUCATION PROGRAMS	WATER QUALITY CONTROL PERSONNEL	TOTAL
ILLINOIS	130	56	186
INDIANA	47	23	70
MICHIGAN	80	41	121
MINNESOTA	53	20	73
OHIO	114	51	165
WISCONSIN	58	22	80
TOTAL	482	213	695

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

The data obtained consist of the responses to each question on the survey instrument. Data were obtained from two sample populations. Information on water quality control education opportunities was collected from businesses, agencies, organizations and educational institutions. Table 6 summarizes the response to this sampling. Information on water quality control personnel was obtained from individuals employed at municipal wastewater treatment facilities. Table 7 summarizes the response to this sampling.

Data analysis was done in two parts. Descriptive statistics and frequencies were obtained through the use of the SPSS program FREQUENCIES (Nie, et al, 1975). The hypotheses were tested by Chi-square and rank order correlations through the use of SPSS programs CROSSTABS and RELIABILITY (Hull and Nie, 1979).

Water Quality Control Education Programs

As shown in Table 6, questionnaires were returned from fifty-seven agencies, businesses, and organizations and two hundred and twelve educational institutions. This represents a 55.80% response from this survey group. Of these responses, 47 (82.45%) of the agencies, businesses, and organizations and 181 (85.37%) of the educational institutions indicated that they did not offer educational opportunities for water quality control personnel. Ten (17.54%) of the

TABLE 6

RESPONSE RATE TO THE WATER QUALITY CONTROL EDUCATION PROGRAMS QUESTIONNAIRE

STATE	AGENCIES AND ORGANIZATIONS			EDUCATIONAL INSTITUTIONS		
	SENT	RETURNED	PERCENT	SENT	RETURNED	PERCENT
ILLINOIS	39	18	46.15	91	54	59.34
INDIANA	6	3	50.00	41	29	70.73
MICHIGAN	18	5	27.77	62	34	54.83
MINNESOTA	10	3	30.00	43	26	60.46
OHIO	38	20	52.63	76	47	61.84
WISCONSIN	20	8	40.00	38	22	57.89
TOTAL	131	57	43.51	351	212	60.39

TABLE 7

RESPONSE RATE TO THE WATER QUALITY CONTROL PERSONNEL QUESTIONNAIRE

STATE	MUNICIPALITIES			SUPERVISOR USABLE RESPONSE		TECHNICIAN USABLE RESPONSE	
	SENT	RETURNED	%	RETURNED	%	RETURNED	%
ILLINOIS	56	43	76.8	31	55.3	26	46.4
INDIANA	23	19	82.6	17	73.9	16	69.5
MICHIGAN	41	31	75.6	23	56.0	22	53.6
MINNESOTA	20	17	85.0	10	50.0	10	50.0
OHIO	51	43	84.3	34	66.6	32	62.7
WISCONSIN	22	22	100.0	20	90.9	20	90.9
TOTAL	213	175	82.15	135	63.38	126	59.15

agencies, businesses and organizations and 31 (14.62%) of the educational institutions did indicate, however, that they offered courses for water quality control personnel.

The data received do not warrant further analysis. The information provided was incomplete. Respondents either failed to answer enough items on the questionnaire for analysis, or marked multiple responses to questions making coding inaccurate. In many cases, information was provided for degree-oriented courses. As these were specifically eliminated from the study, the information was not usable for analysis. Appendix D provides a list of respondents who indicated continuing education-professional development opportunities were available for water quality control personnel.

Water Quality Control Personnel

As shown in Table 7, questionnaires were returned from one-hundred seventy-five municipalities. This represents an 82.15% response for this survey group. Forty municipalities returned the questionnaires unanswered. These municipalities indicated that they did not operate their own wastewater treatment facility. In these cases, responsibility of the municipality was limited to maintaining water distribution lines and sewage transmission systems. Processing of wastewater was either contracted to a neighboring municipality or provided by a metropolitan sanitary district servicing several communities. In eleven cases, a response was received from only the supervisor at the facility rather than both the supervisor and technician as requested. Final data

analysis was conducted on the information received from 135 (63.38%) supervisors and 126 (59.15%) technicians.

Statement of the Null Hypotheses

The following hypotheses were tested for both supervisors and technicians.

Hypothesis 1: There is no relationship between certification status and participation in continuing education activities.

Hypothesis 2: There is no relationship between certification status and familiarity with training courses.

Hypothesis 3: There is no relationship between certification status and importance attached to professional development courses.

Hypothesis 4: There is no relationship between education level and participation in continuing education activities.

Hypothesis 5: There is no relationship between education level and familiarity with training courses.

Hypothesis 6: There is no relationship between education level and importance attached to professional development courses.

Hypothesis 7: There is no relationship between length of employment and participation in continuing education activities.

Hypothesis 8: There is no relationship between length of employment and familiarity with training courses.

Hypothesis 9: There is no relationship between length of employment and importance attached to professional development courses.

Hypothesis 10: There is no relationship between facility treatment level and participation in continuing education activities.

Hypothesis 11: There is no relationship between facility treatment level and familiarity with training courses.

Hypothesis 12: There is no relationship between facility treatment level and importance attached to professional development opportunities by facility personnel.

Testing the Null Hypotheses

Table 8 shows the Chi-Square values and significance levels for each of the twelve hypotheses tested for the supervisors and technicians.

Hypothesis 1: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 0.2661$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 1: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 0.7258$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 2: There is no relationship between a technician's certification status and familiarity with training courses. The Chi-Square value obtained for this relationship was $X^2 = 29.9183$, significant at the .001 level. The null hypothesis is rejected. Table 9 shows the crosstabulation of the relationship between the variables.

Hypothesis 2: There is no relationship between a supervisor's certification status and familiarity with training courses. The Chi-Square value obtained for this relationship was $X^2 = 18.1876$, significant at the .001 level. The null hypothesis is rejected. Table 10 shows the crosstabulation of the relationship between the variables.

TABLE 8

CHI-SQUARE VALUES AND LEVELS OF SIGNIFICANCE
FOR EACH OF THE HYPOTHESES TESTED

HYPOTHESIS	TECHNICIANS	SUPERVISORS
1	0.2661* (0.6059)	0.7258* (0.3942)
2	29.9183 (0.0001)	18.1876 (0.0011)
3	6.0129* (0.1982)	2.4560* (0.6525)
4	1.8302* (0.7669)	12.5681 (0.0136)
5	31.3397 (0.0122)	14.7118* (0.5458)
6	14.5179* (0.5602)	23.7555* (0.0950)
7	0.8524* (0.8369)	4.0981* (0.2511)
8	10.9676* (0.5317)	16.0198* (0.1903)
9	18.7191* (0.0955)	9.0324* (0.7002)
10	0.4653* (0.7924)	1.2341* (0.5395)
11	9.2492* (0.3217)	2.9375* (0.9382)
12	3.3589* (0.9099)	13.4454* (0.0974)

*Not rejected.

TABLE 9

CROSSTABULATION OF CERTIFICATION STATUS
BY FAMILIARITY WITH TRAINING COURSES - TECHNICIANS

	NO KNOWLEDGE OF PROGRAMS	SOME FAMIL-IARITY	KNOWL-EDGEABLE ABOUT ONE	KNOWL-EDGEABLE ABOUT TWO OR MORE	THOR-OUGHLY FAMILIAR WITH MORE THAN ONE	ROW TOTAL
NO						
COUNT	5	9	1	1	4	20
ROW PCT	25.0	45.0	5.0	5.0	20.0	18.0
COL PCT	71.4	42.9	6.7	2.8	12.5	
TOT PCT	4.5	8.1	0.9	0.9	3.6	
YES						
COUNT	2	12	14	35	28	91
ROW PCT	2.2	13.2	15.4	38.5	30.8	82.0
COL PCT	28.6	57.1	93.3	97.2	87.5	
TOT PCT	1.8	10.8	12.6	31.5	25.2	
	7	21	15	36	32	111
	6.3	18.9	13.5	32.4	28.8	100.0

CHI-SQUARE = 29.91 WITH DF = 4 SIGNIFICANCE = 0.0000

TABLE 10

CROSSTABULATION OF CERTIFICATION STATUS
BY FAMILIARITY WITH TRAINING COURSES - SUPERVISORS

	NO KNOWLEDGE OF PROGRAMS	SOME FAMIL-IARITY	KNOWL-EDGEABLE ABOUT ONE	KNOWL-EDGEABLE ABOUT TWO OR MORE	THOR-OUGHLY FAMILIAR WITH MORE THAN ONE	ROW TOTAL
NO						
COUNT	6	14	3	2	4	29
ROW PCT	20.7	48.3	10.3	6.9	13.8	24.6
COL PCT	60.0	40.0	17.6	6.5	16.0	
TOT PCT	5.1	11.9	2.5	1.7	3.4	
YES						
COUNT	4	21	14	29	21	89
ROW PCT	4.5	23.6	15.7	32.6	23.6	75.4
COL PCT	40.0	60.0	82.4	93.5	84.0	
TOT PCT	3.4	17.4	11.9	24.6	17.8	
TOT CT	10	35	17	31	25	118
TOT PCT	8.5	29.7	14.4	26.3	21.2	100.0

CHI SQUARE = 18.19 WITH DF = 4 SIGNIFICANCE = 0.0011

Hypothesis 3: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 6.0129$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 3: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 2.4560$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 4: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 1.8302$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 4: There is no relationship between a supervisor's education level and participation in continuing education programs. The Chi-Square value obtained for this relationship was $X^2 = 12.5681$, significant at the .01 level. The null hypothesis is rejected. Table 11 shows the crosstabulation of the relationship between the variables.

Hypothesis 5: There is no relationship between a technician's education level and familiarity with training courses. The Chi-Square value attained for this relationship was $X^2 = 31.3397$, significant at the .01 level. The null hypothesis is rejected. Table 12 shows the crosstabulation of the relationship between the variables.

Hypothesis 5: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 0.5458$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 6: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 14.5179$. This was not significant at the .05 level. This hypothesis was not rejected.

TABLE 11

CROSSTABULATION OF EDUCATION LEVEL
BY PARTICIPATION IN CONTINUING EDUCATION PROGRAMS - SUPERVISORS

	NO DIPLOMA	HIGH SCHOOL DIPLOMA	ASSOC-IATE DEGREE	BACHELOR DEGREE	MASTER'S DEGREE	TOTAL
NO						
COUNT	7	27	3	7	1	45
ROW PCT	87.5	39.1	16.7	30.4	50.0	37.5
COL PCT	15.6	60.0	6.7	15.6	2.2	
TOT PCT	5.8	22.5	2.5	5.8	0.8	
YES						
COUNT	1	42	15	16	1	75
ROW PCT	12.5	60.9	83.3	69.6	50.0	62.5
COL PCT	1.3	56.0	20.0	21.3	1.3	
TOT PCT	0.8	35.0	12.5	13.3	0.8	
TOT CT	8	69	18	23	2	120
TOT PCT	6.7	57.5	15.0	19.2	1.7	100.0

CHI SQUARE = 12.57 WITH DF = 4 SIGNIFICANCE = 0.0136

TABLE 12

CROSSTABULATION OF EDUCATION LEVEL BY FAMILIARITY WITH TRAINING COURSES - TECHNICIANS

	NO KNOWLEDGE OF PROGRAMS	SOME FAMILIARITY	KNOWLEDGE-ABLE ABOUT ONE	KNOWLEDGE-ABLE ABOUT TWO OR MORE	THOROUGHLY FAMILIAR WITH MORE THAN ONE	ROW TOTAL
NO HIGH SCHOOL DIPLOMA						
COUNT	2	0	0	0	1	3
ROW PCT	66.7	0.0	0.0	0.0	33.3	2.7
COL PCT	28.6	0.0	0.0	0.0	3.0	
TOT PCT	1.8	0.0	0.0	0.0	0.9	
HIGH SCHOOL DIPLOMA						
COUNT	3	15	8	22	17	65
ROW PCT	4.6	23.1	12.3	33.8	26.2	58.0
COL PCT	42.9	71.4	53.3	61.1	51.5	
TOT PCT	2.7	13.4	7.1	19.6	15.2	
ASSOCIATE DEGREE						
COUNT	0	1	1	4	4	10
ROW PCT	0.0	10.0	10.0	40.0	40.0	8.9
COL PCT	0.0	4.8	6.7	11.1	12.1	
TOT PCT	0.0	0.9	0.9	3.6	3.6	
BACHELOR'S DEGREE						
COUNT	0	4	5	7	10	26
ROW PCT	0.0	15.4	19.2	26.9	38.5	23.2
COL PCT	0.0	19.0	33.3	19.4	30.3	
TOT PCT	0.0	3.6	4.5	6.3	8.9	
MASTER'S DEGREE						
COUNT	2	1	1	3	1	8
ROW PCT	25.0	12.5	12.5	37.5	12.5	7.1
COL PCT	28.6	4.8	6.7	8.3	3.0	
TOT PCT	1.8	0.9	0.9	2.7	0.9	
TOT CT	7	21	15	36	33	112
TOT PCT	6.3	18.8	13.4	32.1	29.5	100.0

CHI SQUARE = 31.34 WITH DF = 16 SIGNIFICANCE = 0.0122

Hypothesis 6: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 23.7555$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 7: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 0.8524$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 7: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 4.0981$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 8: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 10.9676$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 8: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 16.0198$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 9: The Chi-Square determined in testing this hypothesis for technicians was $X^2 = 18.7191$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 9: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 9.0324$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 10: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 0.4653$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 10: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 1.2341$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 11: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 9.2492$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 11: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 2.9375$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 12: The Chi-Square value determined in testing this hypothesis for technicians was $X^2 = 3.3589$. This was not significant at the .05 level. This hypothesis was not rejected.

Hypothesis 12: The Chi-Square value determined in testing this hypothesis for supervisors was $X^2 = 13.4454$. This was not significant at the .05 level. This hypothesis was not rejected.

The Water Quality Control Professional

Questionnaires were returned from one hundred twenty-seven supervisors and one hundred twenty-two technicians at municipal wastewater treatment facilities. Their responses provided information on variables descriptive of the water quality control professional.

Level of Education, Table 13, displays the responses for technicians and supervisors regarding their level of education. Fifty-four percent of the supervisors and sixty percent of the technicians indicated that a high school diploma was the highest education level attained. The next most frequently checked level was a Bachelor's

Degree, where 24% of the supervisors and 16.5% of the technicians indicated they had reached this level. Eleven supervisors and seventeen technicians checked the Associate Degree level. A small percentage of individuals in each classification have a Master's Degree, none have a Doctoral Degree, and twelve respondents indicated they did not have a high school diploma.

TABLE 13

EDUCATION LEVEL OF SAMPLE SUPERVISORS AND TECHNICIANS

	SUPERVISORS		TECHNICIANS	
	#	%	#	%
No diploma	5	4.1	7	6.1
High School diploma	66	54.1	69	60.0
Associate Degree	11	9.0	17	14.8
Bachelor Degree	30	24.6	19	16.5
Masters Degree	10	8.2	3	2.6
Doctorate	0	0.0	0	0.0
TOTAL	122	100.0	115	100.0

Choice of Job - The data in Table 14 indicate that most of the personnel surveyed selected their current position because it was their major area of interest. The next most frequently checked response indicates that the job was chosen because it was the only position available where the individual desired work. A few individuals in each category selected their position because it was the one for which they were best qualified. When considering salary as a

deciding factor, 17 technicians and 7 supervisors checked this option as their reason for job selection.

TABLE 14

REASONS FOR JOB SELECTION
OF SAMPLE SUPERVISORS AND TECHNICIANS

	SUPERVISORS		TECHNICIANS	
	#	%	#	%
Amount of pay	7	5.8	17	15.3
Major interest	71	59.2	53	47.7
Only position	23	19.2	21	18.9
Best qualified	19	15.8	20	18.0
TOTAL	120	100.0	111	100.0*

*Difference due to rounding.

Employment - Tabulation of the responses (Table 15) indicates 49.2% of the supervisors have been employed at the same facility for eleven years or more; 16.4% have been at the same facility from two to five years; and 29.5% have been there from five to ten years. The data further show that 32.0% have been in their position for two to five years, 19% for six to ten years, and 27.9% for eleven years or more.

For technicians (Table 16), 31.3% indicated they have been employed at the same facility for eleven years or more; 22.6% have been at the same facility from six to ten years; and 41.7% have been there from two to five years. The data further show that 54% of the technicians have been in their present capacity for the period two to

five years. Thirteen percent have been in their capacity for eleven years or more; 19% for six to ten years; and 14% for one year or less.

TABLE 15

EMPLOYMENT PATTERN OF SAMPLE PERSONNEL - SUPERVISORS

	EMPLOYED AT FACILITY NUMBER	PERCENT	EMPLOYED IN CAPACITY NUMBER	PERCENT
One year or less	6	4.9	25	20.5
2 to 5 years	20	16.4	39	32.0
6 to 10 years	36	29.5	24	19.7
11 years or more	60	49.2	34	27.9
TOTAL	122	100.0	122	100.0*

TABLE 16

EMPLOYMENT PATTERN OF SAMPLE PERSONNEL - TECHNICIANS

	EMPLOYED AT FACILITY NUMBER	PERCENT	EMPLOYED IN CAPACITY NUMBER	PERCENT
One year or less	5	4.3	16	13.9
2 to 5 years	48	41.7	62	53.9
6 to 10 years	26	22.6	22	19.1
11 years or more	36	31.3	15	13.0
TOTAL	115	100.0*	115	100.0*

*Difference due to rounding.

Salary - Forty-two percent of the supervisors are in the $18,000-$24,000 salary bracket; 36% earn more than $24,000; and, 17% earn between $12,000 and $18,000.

For technicians, 65.2% are in the $12,000-$18,000 salary bracket, and 20.0% earn between $18,000 and $24,000.

Certification/Registration - In both categories, the majority 84.3% of the supervisors and 71.9% of the technicians are certified wastewater control personnel. Only two (1.8%) of the technicians responding were registered engineers and only 17 (14%) of the supervisors indicated that they were registered engineers.

Organization Membership - Supervisors more than technicians indicated they were members of professional water quality organizations. Ninety-four (78%) supervisors indicated membership, while only thirty-eight (34%) technicians responded that they participated in professional organizations.

Professional Development - The data indicate that during the last year, 63% of the technicians and 73% of the supervisors participated in some aspect of continuing education/professional development related to their job. Both groups indicated that the instruction generally was not given on-site. Sixty-five percent of the technicians and eighty-one percent of the supervisors had received instruction at locations other than their place of employment.

When asked to respond to their reasons for participating in continuing education/professional development opportunities, there were mixed responses between the two groups. Technicians were fairly evenly divided. The data indicate that 38% participated for up-dating, 33%

for up-grading, and 30% for certification. Supervisors, however, participated decidedly, 57% for up-dating, 33% for up-grading, and only 9% participated for certification (Table 17).

TABLE 17

REASONS FOR PARTICIPATION IN CONTINUING EDUCATION OF SAMPLE SUPERVISORS AND TECHNICIANS

	SUPERVISORS		TECHNICIANS	
	NUMBER	PERCENT	NUMBER	PERCENT
Updating	65	57.5	39	37.5
Upgrading	38	33.6	34	32.7
Certification	10	8.8	31	29.8
TOTAL	113	100.0*	104	100.0

*Difference due to rounding.

Because of the high percentages of participation in professional development opportunities during the last year, it was not surprising that the respondents were familiar with educational opportunities (Table 18) directed toward water quality control. For technicians, 25% indicated they had knowledge of two or more courses, and 30% indicated some familiarity. Only 9% stated that they had no knowledge of such programs. Supervisors expressed a greater knowledge of courses with 31% knowledgeable about two or more courses and 31% thoroughly familiar with more than one opportunity. Only 7% of the supervisors indicated they had no knowledge of such programs.

TABLE 18

SAMPLE POPULATION FAMILIARITY WITH CONTINUING EDUCATION PROFESSIONAL DEVELOPMENT OPPORTUNITIES

	SUPERVISORS		TECHNICIANS	
	NUMBER	PERCENT	NUMBER	PERCENT
No knowledge	8	6.6	10	8.8
Some familiarity	24	19.8	34	30.1
Knowledgeable about at least one	14	11.6	19	16.8
Knowledgeable about two or more	38	31.4	29	25.7
Thoroughly familiar with more than one	37	30.6	21	18.6
TOTAL	121	100.0	113	100.0*

*Difference due to rounding.

Eighty percent of the supervisors and eighty-four percent of the technicians indicated that professional development courses could be helpful or extremely helpful.

Reasons for Participating in Continuing Education - Respondents were asked to rank in order of importance their reasons for participating in continuing education-professional development opportunities. Tables 19 and 20 present the tabulation of this data.

For both supervisors and technicians, participation to obtain an advanced degree was ranked lowest. For supervisors, the other choices were ranked almost evenly with participation to increase responsibilities on the job a slight favorite. The responses for technicians were more widely distributed, with most of these individuals ranking "to perform job better" as most important.

Areas of Training - Respondents were asked to indicate, from a list of twenty training areas, those which would be most helpful to meet job responsibilities. Table 21 displays the training areas, the number of supervisors and technicians who checked each area, and the associated rankings.

For technicians, the five top-ranked training areas are: equipment maintenance, treatment technology-biological, equipment operation, treatment technology-physical/chemical, and laboratory procedures. For supervisors, the five top-ranked training areas are: management skills-employee relations, equipment maintenance, treatment technology-biological, management skills-communications, and treatment technology-advanced.

TABLE 19

RANK OF CONTINUING EDUCATION PARTICIPATION OUTCOMES - SUPERVISORS

	1	2	3	4	5	TOTAL
Obtain advanced degree	7.6	69.0	1.9	18.2	6.5	103.2
Perform job better	3.8	22.1	10.5	51.8	11.2	99.4
Increase responsibilities	8.6	6.2	21.9	20.0	42.1	98.8
Keep up-to-date	17.1	1.8	53.3	6.4	20.6	99.2
Meet organization's expectations	62.9	0.9	12.4	3.6	19.6	99.4
TOTAL	100.0	100.0	100.0	100.0	100.0	

TABLE 20

RANK OF CONTINUING EDUCATION PARTICIPATION OUTCOMES - TECHNICIANS

	1	2	3	4	5	TOTAL
Obtained advanced degree	19.2	51.9	6.1	21.6	9.0	107.8
Perform job better	11.5	24.5	14.1	33.3	12.0	95.4
Increase responsibilities	15.4	16.0	27.3	23.5	15.0	97.2
Keep up-to-date	17.3	6.6	34.3	14.7	25.0	97.9
Meet organization's expectations	36.5	0.9	18.2	6.9	39.0	101.5
TOTAL	100.0	100.0	100.0	100.0	100.0	

TABLE 21

AREAS OF TRAINING

	TECHNICIANS	RANK	SUPERVISORS	RANK
Treatment Technology - biological	74	2	65	4
Treatment Technology - physical/chemical	67	4	52	8
Treatment Technology - advanced	56	9	60	5
Equipment Operation	68	3	60	5
Equipment Maintenance	75	1	70	2
Equipment Evaluation	57	8	47	9
Water Quality - inorganic analysis	52	11	33	15
Water Quality - organic analysis	53	10	38	13
Water Quality - surveillance/monitoring	61	7	55	7
Laboratory Procedures	65	5	45	10

TABLE 21 (CONTINUED)

AREAS OF TRAINING

	TECHNICIANS	RANK	SUPERVISORS	RANK
Basic Math/statistics	45	13	34	14
Basic Engineering principles	35	16	45	10
Management Skills - employee relations	47	12	83	1
Management Skills - communications	42	14	67	3
Management Skills - public participation	25	18	59	6
Legislation/Policies	20	19	41	11
General Ecology	29	17	20	16
Safety	64	6	52	8
Environmental Impact Analysis	39	15	40	12
Others	7	20	3	17

Equipment maintenance and treatment technology-biological were important training areas identified by both groups.

Further tabulation of the data by municipal size was conducted on the information received from the respondents. This analysis provided additional descriptive information on the water quality control professional and the facilities where they are employed.

Treatment Level - Tabulation of the data (Table 22) indicate that wastewater treatment facilities, across all municipal levels, are generally in compliance with the legislative mandates requiring secondary or better treatment of wastewater.

TABLE 22

TREATMENT LEVEL OFFERED BY MUNICIPAL POPULATION CATEGORY

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M	TOTAL
Primary	4	1	3	0	8
Secondary	20	22	12	13	67
Tertiary	9	7	4	6	26
TOTAL	33	30	19	19	101

Educational Level - Tabulation of the data by municipal population (Table 23) shows slight differences in the educational levels of the operations personnel. For municipalities with a population between 5,000 and 25,000, the personnel are generally high school graduates or those who have an Associate Degree. For municipalities with a population of 25,000 to 50,000 and 50,000 to 100,000 the larger number of

operators are high school graduates but there is an increase in the number of personnel holding a Bachelor's Degree. Municipalities of 100,000 or more indicate slightly more of the personnel have a Bachelor's Degree. This difference is primarily accounted for by the higher educational levels of the supervisors.

TABLE 23

EDUCATIONAL LEVEL OF SUPERVISORS AND TECHNICIANS COMBINED BY MUNICIPAL POPULATION CATEGORY

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M	TOTAL
No Diploma	5.94	3.63	0.00	4.54	3.69
High School Diploma	49.50	45.45	34.28	25.00	41.53
Associate Degree	10.89	5.45	4.28	18.18	8.61
Bachelor's Degree	8.91	15.45	12.85	31.81	15.07
Master's Degree	.99	3.63	4.28	11.36	4.00
Doctorate	0.00	0.00	0.00	0.00	0.00
Missing	23.76	26.36	44.28	9.09	27.07
TOTAL*	100.00	100.0	100.0	100.0	100.0

*Difference due to rounding.

Salary - Table 24 displays the data by municipal population category.

Reasons for Participating in Continuing Education - Table 25 displays the data from respondents with regard to their reasons for participating in continuing education-professional development opportunities.

TABLE 24

SALARY LEVEL OF SUPERVISORS AND TECHNICIANS
COMBINED BY MUNICIPAL POPULATION CATEGORY

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M	TOTAL
Less than $6,000	2.9	1.8	0.0	0.0	1.5
$6,000-$12,000	10.9	1.8	1.4	0.0	4.3
$12,000-$18,000	38.6	27.3	20.0	29.5	29.5
$18,000-$24,000	17.8	28.1	22.8	20.4	22.8
More than $24,000	5.9	14.5	11.4	40.9	14.8
Missing	23.7	26.4	44.3	9.0	27.0
TOTAL*	100.0	100.0	100.0	100.0	100.0

*Differences due to rounding.

TABLE 25

REASONS FOR PARTICIPATING IN CONTINUING EDUCATION
BY MUNICIPAL POPULATION CATEGORY

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M	TOTAL
Updating	27.7	34.5	24.3	47.7	32.0
Upgrading	25.7	23.6	14.3	22.7	22.1
Certification	18.8	10.9	11.4	4.5	12.6
Missing	27.7	30.9	50.0	25.0	33.2
TOTAL*	100.0	100.0	100.0	100.0	100.0

*Differences due to rounding.

Areas of Training - Respondents were asked to indicate from a list of twenty training areas those which would be most helpful to meet job responsibilities. Tables 26 and 27 indicate the rank ordering of opportunities by supervisors and technicians by municipal population category.

The Treatment Facility

Questionnaires were returned from one hundred seventy-five municipalities. The responses provided information on variables descriptive of the wastewater treatment facility.

Treatment Level - Tabulation of the data indicate that 67% of the facilities offer secondary treatment; 24% offer tertiary treatment, and 9% offer only primary treatment. One municipality indicated that treatment was done by four stabilization lagoons.

Construction/Renovation - The data (Table 28) indicate that over half, 53%, of the facilities were constructed in 1959 or before. Twenty-one percent were constructed during the 1960's and 26% were constructed during the 1970's. It was further indicated that in the 1970's, major upgrading was conducted at 80% of the facilities; 50% of this activity since 1975. Fifteen percent indicated that the last major upgrading to the facility was done in the 1960's, and 5% of the facilities have had no major upgrading in the last twenty years.

Operation - Tabulation of the data indicate that 23% of the facilities operate at their design capacity; 18.5% operate above capacity; and 58% operate below capacity. The hydraulic load of the municipalities (62%) is less than ten MGD. The data indicate that the percentage of daily flow devoted to treatment of industrial effluent

TABLE 26

AREAS OF TRAINING BY MUNICIPAL POPULATION CATEGORY - SUPERVISORS

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M
Treatment Technology - biological	3	4	3	5
Treatment Technology - physical/chemical	4	9	5	8
Treatment Technology - advanced	7	4	2	6
Equipment Operation	7	3	4	7
Equipment Maintenance	2	2	4	6
Equipment Evaluation	11	5	5	9
Water Quality - inorganic analysis	9	11	11	11
Water Quality - organic analysis	8	10	10	10
Water Quality - surveillance/monitoring	4	6	6	8
Laboratory Procedures	3	7	11	12

TABLE 26 (CONTINUED)

AREAS OF TRAINING BY MUNICIPAL POPULATION CATEGORY - SUPERVISORS

	5M-25M	25M-50M	50M-100M	GREATER THAN 100M
Basic Math/statistics	10	11	8	12
Basic Engineering principles	5	10	6	11
Management Skills - employee relations	1	1	1	1
Management Skills - communications	2	5	3	2
Management Skills - public participation	3	6	7	3
Legislation/Policies	12	10	7	4
General Ecology	13	12	9	13
Safety	6	8	6	5
Environmental Impact Analysis	8	10	7	11
Others	14	13	12	13

TABLE 27

AREAS OF TRAINING BY MUNICIPAL POPULATION CATEGORY - TECHNICIANS

	5M-25M	25-50M	50M-100M	GREATER THAN 100M
Treatment Technology - biological	3	1	2	1
Treatment Technology - physical/chemical	5	3	1	2
Treatment Technology - advanced	5	6	3	5
Equipment Operation	2	4	2	2
Equipment Maintenance	1	1	2	5
Equipment Evaluation	7	5	4	3
Water Quality - inorganic analysis	10	5	4	5
Water Quality - organic analysis	9	5	5	4
Water Quality - surveillance/monitoring	10	3	2	1
Laboratory Procedures	4	2	2	5

TABLE 27 (CONTINUED)

AREAS OF TRAINING BY MUNICIPAL POPULATION CATEGORY - TECHNICIANS

	5M-25M	25-50M	50M-100M	GREATER THAN 100M
Basic Math/statistics	8	7	5	6
Basic Engineering principles	9	8	7	8
Management Skills - employee relations	8	9	3	5
Management Skills - communications	10	11	3	5
Management Skills - public participation	11	13	8	6
Legislation/Policies	13	12	7	9
General Ecology	12	10	6	8
Safety	6	5	1	1
Environmental Impact Analysis	12	7	3	7
Others	14	14	9	9

TABLE 28

CONSTRUCTION/RENOVATION DATA FOR MUNICIPAL TREATMENT FACILITIES

	PERCENT CONSTRUCTED	PERCENT RENOVATED
1975 - Present	15.9	50.0
1970 - 1974	9.7	30.6
1965 - 1969	15.0	10.2
1960 - 1964	6.2	4.6
1959 or before	53.1	4.6

ranged from 0% to 100%. Sixty-four percent of the facilities indicated that 25% or less of their volume was industrial effluent. Twelve percent reported no industrial effluent was processed.

Administration - Responses indicated that 30% of the municipalities surveyed did not process their own wastewater and were responsible only for maintaining distribution systems. Twenty-two percent of responses indicated they are part of a joint facility for two or more communities or special district, and 47% of the facilities serve a single municipality.

Training - Seventy-eight percent of the facilities indicated that in-service education was available to the employees. It was further indicated from the data that this training is available on a regular basis in only 50% of the facilities. Responses were almost evenly matched, 54% yes to 46% no, in response to an incentive being provided by the facility for participation in professional development opportunities.

ANALYSIS OF THE DATA

Continuing Education Professional Development Opportunities - Analysis of the data collected in this study from businesses, organizations, agencies, and educational institutions indicate that few opportunities are available for the continuing professional development of water quality control personnel. The current emphasis, as expressed in the survey response, is directed to degree-oriented programs for individuals planning to enter the field. Associate Degree programs are available for technicians through course offerings at two-year institutions and Bachelor Degree programs in engineering, engineering technology, and related water quality control fields are available through four-year institutions.

The educational opportunities reported by institutions were generally part of these degree programs and were offered over one or more semesters or quarters. Since these opportunities do not meet the criteria established for the study, no further analysis was conducted.

In addition to the degree-oriented programs, some respondents provided information on correspondence courses or self-study activities to assist water quality control personnel in meeting certification requirements. Since these opportunities do not meet the criteria established for the study, no further analysis was conducted.

Agencies, businesses, and professional organizations reported that some short courses and conferences were offered for the professional development of water quality control personnel. The information provided, however, was generally incomplete, ambiguous, or confusing. Either information for several educational opportunities was listed on

one questionnaire or multiple responses to questions were checked. Both of these situations precluded a reliable analysis of the information. Some of the ambiguity was clarified through follow-up contacts but the small percentage of response does not lend itself to extensive analysis.

The information collected, however, reveals that of the few opportunities available most are conducted in the lecture format. Little emphasis was placed on discussion or interaction and only laboratory activities stressed participant involvement. In general, the courses identified deal with specific problems of water quality control rather than theory or generalities; and, in general, no specific texts or manuals were used. The materials utilized were collected by the speaker-instructor from various sources and adapted to meet the needs of the presentation.

The data also indicate that evaluation of participants is conducted in the standard paper-and-pencil testing method and that formal evaluation of content, materials, or instruction is cursory.

Wastewater Treatment Facilities - The data indicate that wastewater treatment facilities within Region V are generally small operations, mostly under ten million gallons per day, and are operated on a single municipality basis. Only in the large metropolitan areas such as Chicago, Minneapolis, Detroit, Cleveland, and Cincinnati, has treatment been coordinated into a sanitary district. Personnel numbers at treatment facilities directly reflect the differences in operation. Small single municipality facilities are generally staffed by ten or fewer individuals including maintenance and clerical personnel. The

larger sanitary districts may employ as many as 150 individuals to coordinate all aspects of their operation.

The data received from municipal wastewater treatment facilities seem to support the mandates as set forth in P.L. 92-500 (The Federal Water Pollution Control Act Amendments of 1972). The majority of the treatment facilities provide secondary or better treatment, with only a few facilities still in need of upgrading to bring them into compliance.

The rate of facility construction and renovation seem to indicate that use of the Federal construction grant monies which were made available during the 1970's is coming to fruition. The data further indicate this emphasis on facility and equipment. Although on-the-job training and continuing education-professional development are important for keeping personnel up-to-date, incentive programs are not generally available.

Water Quality Control Personnel - The data collected from the supervisors and technicians provides information about their education, employment, professional development activities and other demographic variables. Most individuals in both employment classifications indicated that a high school diploma was the highest education level attained. It was further indicated that few individuals were registered engineers; however, those with engineering degrees wre usually employed in the supervisory positions. For the few technicians who are registered engineers, they are generally employed at facilities in the larger municipalities. This information does not support the dichotomy between the professional and paraprofessional categories of operations

personnel which was expressed by professional organizations. There is, however, a general increase in the educational level of personnel corresponding to the increase in municipal population level.

A similar increase in salary level with increasing municipality size is indicated in the data from respondents. Overall, technicians are generally in the $12,000 - 18,000 bracket and supervisors are in the $18,000 - 24,000 bracket. In smaller municipalities, the range of salaries covers all categories listed. In the larger municipalities, however, the salaries are clustered at the upper end of the scale with almost half of the respondents indicating they received a salary in excess of $24,000.

The data collected further indicate that most of the personnel surveyed selected their current position because it was their major area of interest. In general, the technicians have been employed at their present facility for five or more years but in their present capacity for the period two to five years. Supervisors, however, indicated that in general they have been employed at their present facility for eleven or more years but over half indicated they have been employed in their present capacity for less than five years. Both of these responses indicated a tendency for promotion through the ranks as positions became available.

Continuing education-professional development opportunities play an important role in helping personnel prepare for advancement and certification. The data supported the certification requirements for water quality control personnel. The respondents are either certified or working toward certification in one of the operations

classifications available within their state. More importantly, however, is the importance given to educational opportunities for updating. For both supervisors and technicians in all municipal population categories, the reason given most often for participating in educational opportunities was for updating. Supervisors indicated that these opportunities help them increase their responsibilities. Technicians responded that participation in these opportunities was to help them perform their job better.

Even though a large number of educational opportunities was not identified by this study, the supervisors and technicians expressed a surprising knowledge about continuing education-professional development activities. The data indicate that most of these opportunities are available at locations other than the treatment plant. Both supervisors and technicians indicated that they had participated in educational opportunities during the last year and these activities were helpful or extremely helpful in meeting job responsibilities and keeping up-to-date.

The data reveals a significant relationship for technicians between their education level and familiarity with training opportunities. On the whole, they expressed a greater familiarity than the supervisors. This may be accounted for, in part, by their need for certification in their present classification or training required to advance to the next classification level. Although supervisors did not show a similar familiarity, they did show a significant relationship between education level and participation in professional development opportunities. This may, in part, be due to a generally higher

education level overall as well as more frequent opportunities to be away from the facility to participate in available programs.

Potential participation in educational opportunities for updating and upgrading is expressed by the course areas of interest. Overall, both supervisors and technicians are interested in specific treatment technologies and equipment maintenance and operation. Additionally, supervisors expressed an interest in management skills, especially employee relations and communications. When analyzed by municipal population category, there are differences expressed in the course areas of interest. For technicians, emphasis is still on treatment technologies and equipment, but there is a broader range of interest with increasing municipal size. This suggests more specialized job requirements for the technicians in the larger municipal facilities. For supervisors, a broader range of interest is exhibited with decreasing municipal size. This suggests more varied job requirements for the supervisor in the small municipal facilities. The major emphasis is still on management skills. This is to be expected as the data indicate many of the supervisors are relatively new to this position.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The information collected through this study provides insight into the operation of municipal wastewater treatment facilities and the personnel employed at these facilities. Emphasis during the last ten years has focused on the construction and renovation of physical plants and equipment to meet the mandates of legislation for secondary or better treatment of wastewater. New and better equipment has been introduced. New treatment technologies have been developed and implemented. Little attention, however, has been directed to the training of personnel responsible for operating the facility in compliance with the new regulations and mandates. The purpose of this study was to identify these educational opportunities, their areas of emphasis, and collect this information in a central location.

In addition to establishing a listing of educational opportunities for water quality control personnel, the study attempted to provide a comparison of these opportunities with those opportunities operations personnel identified as important for professional development.

The main objective of this study was to investigate and provide information concerning the relevant educational opportunities for

water quality control personnel as perceived by the sponsors of these opportunities and the personnel currently employed in the profession. The accomplishment of this objective required the investigation of several sub-objectives.

1. To survey the existing literature from a variety of applicable sources and derive a set of elements germane to the water quality control profession.
2. To build these elements into a survey instrument and have them professionally screened.
3. To select and contact a sample of operations personnel and program sponsors for the purpose of obtaining data via the questionnaire, for each respondent.
4. To ascertain, by statistical analysis, those educational opportunities which personnel deem most essential to professional development.
5. To ascertain, by statistical analysis, those educational opportunities which program sponsors deem most essential to professional development.
6. To compare the findings of sub-objective four with those of sub-objective five.

The scope of this study was concerned with data obtained through the survey methodology from currently employed wastewater treatment plant personnel and sponsors of educational opportunities in the U.S. Environmental Protection Agency Region V.

Collection of data via the survey questionnaire took place during the Spring of 1980. Responses were received from 269 businesses,

agencies, organizations, and educational institutions and 175 municipal wastewater treatment facilities. The responses to the survey items were coded and keypunched for tabulation.

The data treatment on the responses was primarily descriptive in nature. The Chi-square test was applied to the data from personnel to determine on which variables there was significant difference.

Data received from businesses, agencies, organizations, and educational institutions was incomplete or inappropriate to the study. No further analysis was undertaken.

According to the results of this study, there is an expressed need by water quality control personnel for educational opportunities for updating, upgrading, and certification. The opportunities of most value to the water quality control operator are: treatment technologies, equipment operation and maintenance, management skills, safety, and communications. These areas provide a starting point for the development of educational opportunities for the professional development of water quality control personnel. Agencies, businesses, organizations, and educational institutions should strive to meet this need.

Conclusions

Generalizations based on the findings of this study must take into account the particular samples of respondents, the nature of the survey instrument, and the procedures used to analyze the data. However, in view of the information yielded, certain conclusions seem warranted.

1. There is a significant lack of educational opportunities for the professional development of water quality control personnel. Sponsors of educational opportunities, especially educational institutions, should be more responsive to the needs of the currently employed water quality control professional. Degree-oriented programs are helpful for training future operations personnel, but rapidly changing technology in the field requires opportunities for updating of personnel.

2. The response regarding available educational opportunities is not consistent with the amount of participation indicated by personnel. Several factors may account for this difference. First, respondents were referring to in-house activities and on-the-job training as professional development opportunities. Second, the educational opportunities are offered on a local or state basis but are sponsored through a national organization headquartered outside the study area and as a result not surveyed. Third, the survey instrument was not forwarded to an appropriate division or individual within an educational institution. These possibilities must be considered when making determinations regarding further research or development of educational opportunities.

3. There are differences among the states in their approach to water quality control and requirements for operations personnel. Wisconsin, where water quality control is monitored by the Department of Natural Resources, exhibits a highly structured system with an established program of educational opportunities for water quality control personnel. Conversely, Michigan exhibits a loosely structured

system and presently has no established program of educational opportunities for personnel. This diversity suggests that investigation on a state-by-state basis may be more conclusive than a regional approach.

4. Employee classification, education level, and municipal size as variables are related to participation in, familiarity with, and importance attached to continuing education-professional development opportunities. These variables accounted for the differences expressed by personnel regarding educational opportunities of importance. Future development of continuing education-professional development opportunities for water quality control personnel must consider these variables as important.

5. There are areas of common agreement on the educational opportunities relevant for water quality control personnel across employment classifications. Opportunities relevant to operations personnel can be identified. These areas include specific treatment technologies and equipment operation and maintenance.

6. There are differences between supervisors and technicians in the overall rankings for educational opportunities. The respective rankings of each group coincide directly with job responsibilities. For technicians, interest is expressed in operational concerns for treatment technologies and equipment use. Supervisors expressed interest in the administratively oriented areas stressing management skills.

7. The survey methodology provides a usable technique to collect information from water quality control personnel regarding relevant educational opportunities.

8. Wastewater treatment plant personnel can be surveyed for the purpose of obtaining data on relevant educational opportunities for water quality control personnel.

9. Water quality control personnel are a valuable source of data from whom to seek input into educational opportunities for such persons.

Recommendations

The conduct of this study has brought to the attention of the investigator numerous avenues and implications for further research.

Rapidly changing technology and legislative mandates will continue to alter the job requirements for water quality control personnel and there remains a need for research into the educational opportunities for their continuing professional development. The discovery of content areas valuable to operations personnel will provide positive implications for more intelligent decisions concerning the development of educational opportunities in the water quality control field.

Examples of variations from the present study which may be further investigated are:

1. Although the water quality control programs questionnaire developed and utilized in this study did not prove fruitful, the use of such an instrument for obtaining the information on educational opportunities deserves further investigation.

2. Another dimension that could be added to the conduct of such studies would be a more stringent set of criteria for the selection of agencies, businesses, organizations, and educational institutions to be surveyed.
3. Rather than using a written survey instrument distributed by mail, a future study might effectively use the interview methodology, either by phone or personal contact. This approach would allow the investigator to collect more current information on the educational opportunities available. In addition, it provides a means to guard against ambiguous or incomplete responses.
4. The same instrument used in this study might effectively be used in studies on other employment classifications such as laboratory personnel, facility managers, supervisors, and water treatment operations personnel.
5. Also, other studies might experiment with broadening or limiting the educational opportunities of interest, restricting the investigation to in-service or on-the-job training offered in the larger municipal facilities. Data from studies of this nature can provide information important and helpful in the development and implementation of educational opportunities for water quality control personnel.
6. Every effort should be made to encourage further research into the educational opportunities of importance to water quality control personnel. The survey methodology is a useful technique not only for program sponsors and the

National Training and Operational Technology Center in the building of program content, but also for the municipal administration in helping to close the gap between the needs of facility personnel and the operations requirements to meet legislative criteria and mandates.

7. There is an expressed need for educational opportunities. Wastewater treatment plant personnel are seeking information on all facets of operation. They are interested in new equipment, maintaining older equipment, improving wastewater treatment, reducing costs and increasing plant efficiency. Agencies, businesses, organizations and educational institutions should strive to meet this need.

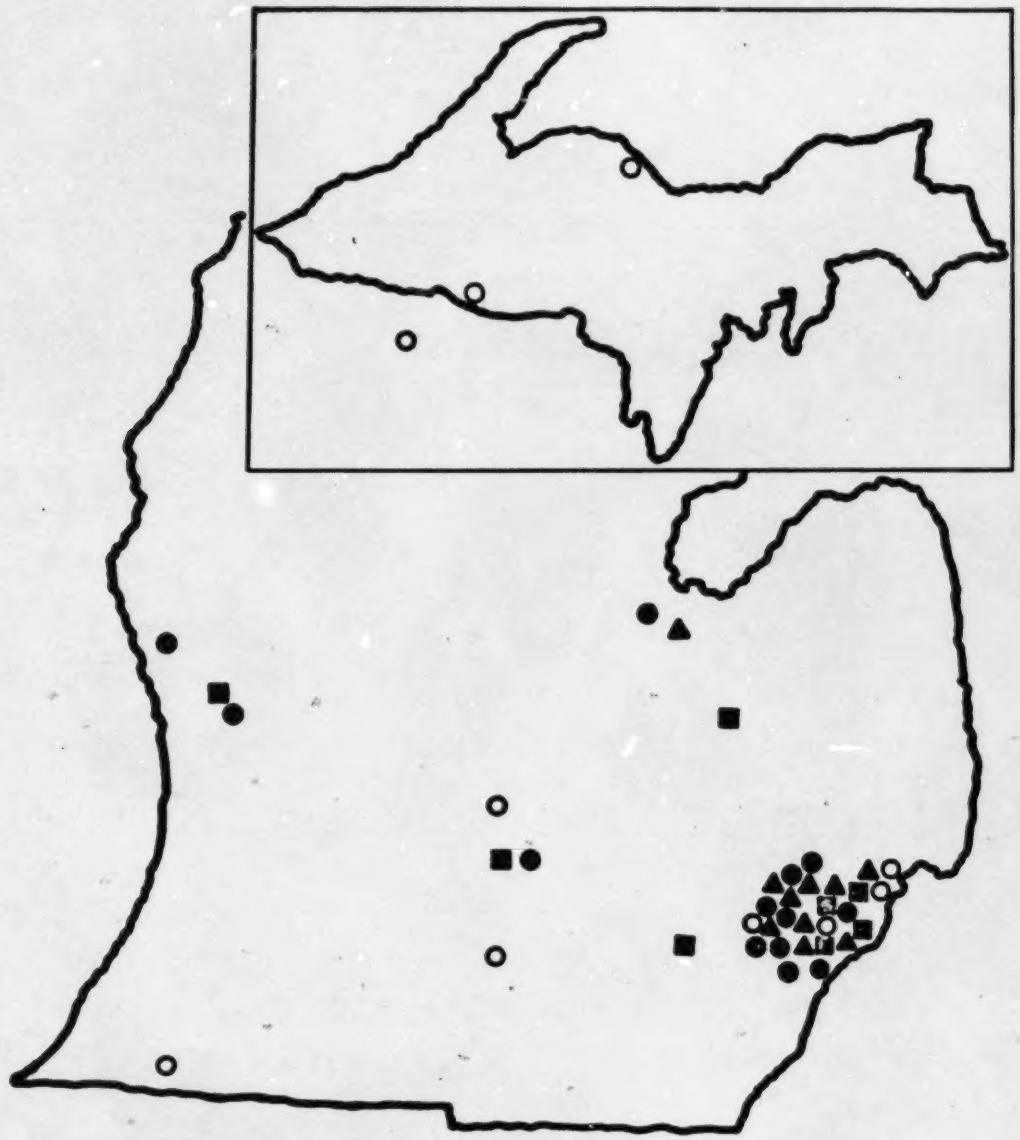
APPENDIX A

GEOGRAPHICAL DISTRIBUTION

OF SAMPLE MUNICIPALITIES BY STATE

FIGURE 8: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN ILLINOIS

FIGURE 9: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN INDIANA



LEGEND

○ 5,000 - 25,000
● 25,000 - 50,000
▲ 50,000 - 100,000
■ greater than 100,000

FIGURE 10: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN MICHIGAN

FIGURE II: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN MINNISOTA

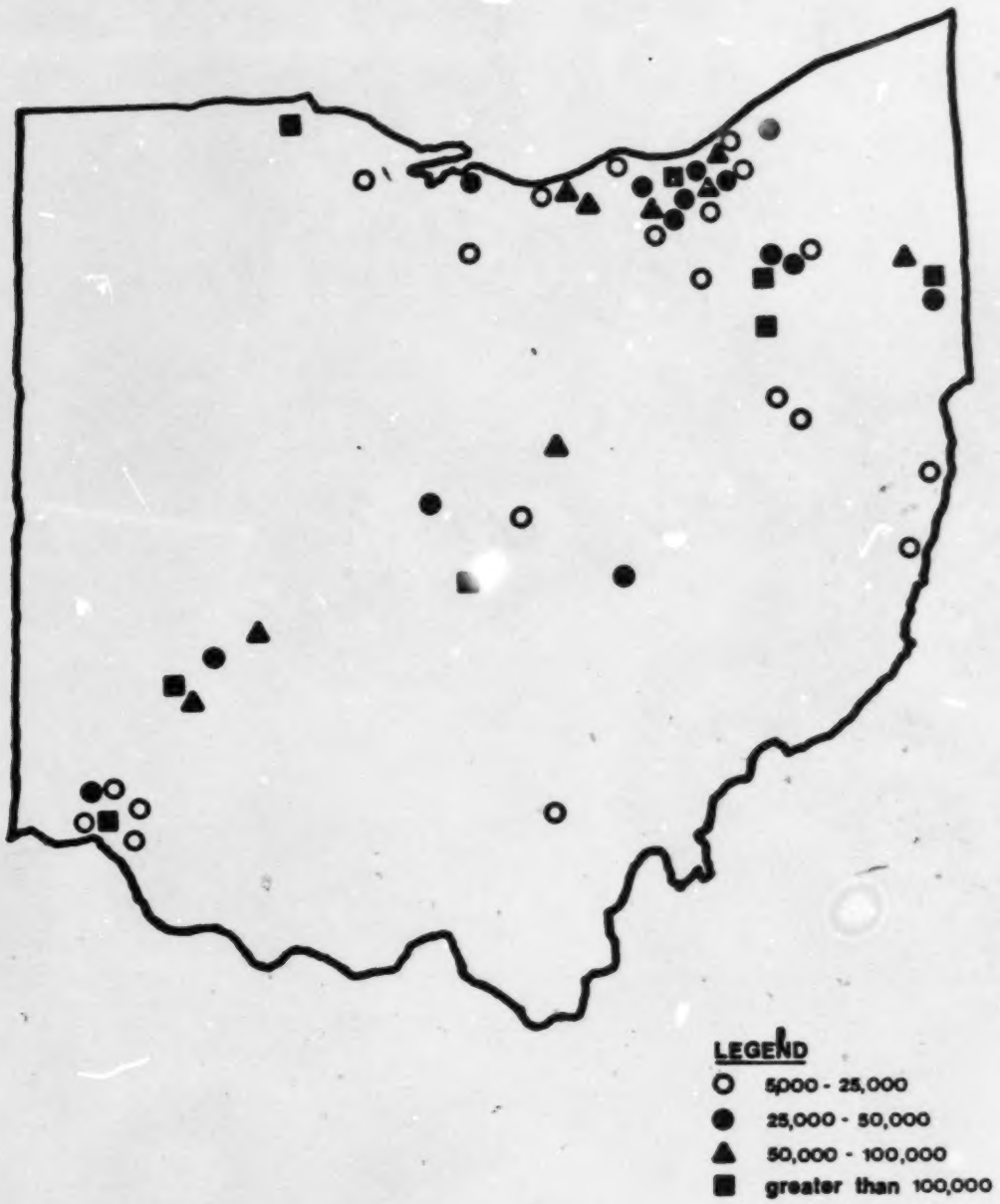


FIGURE 12: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN OHIO

LEGEND

- ○ 5,000 - 25,000
- ● 25,000 - 50,000
- ▲ 50,000 - 100,000
- ■ greater than 100,000

FIGURE 13: GEOGRAPHICAL DISTRIBUTION OF SAMPLE MUNICIPALITIES IN WISCONSIN

APPENDIX B

COVER LETTER

AND

WATER QUALITY CONTROL EDUCATION PROGRAMS QUESTIONNAIRE

OSU

The Ohio State University

EPA Information Dissemination Project
Room 209
1200 Chambers Road
Columbus, Ohio 43212
Phone 614 422-6717

February 3, 1980

TO: Director, Continuing Education Programs

The Ohio State University has undertaken a pilot project in relation to the water quality control profession. This project will assess the availability of professional development opportunities within the six state area comprised of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

This project has come about as a result of an unequal distribution of enrollments in identified training opportunities within the study area. Identification of additional training opportunities can assist potential participants in locating course sponsors and help distribute the enrollments more equally.

Activities of interest in this survey focus on:
1. courses concerned with the updating, upgrading or certification of water quality control personnel.
2. courses of short-term duration(partial day, several days, two weeks).
3. courses which have an organized format, syllabus, or outline; and,
4. courses which are offered on some regular basis.

While courses which are part of degree-oriented programs may meet the criteria outlined, they are fairly-well documented. The intent here is to identify short-courses, workshops, seminars, and conferences.

Does your organization offer courses which meet these criteria?

If YES, place a check (√) here _____. Then please provide the information requested and return the completed questionnaire in the envelope provided.

If NO, place a check (√) here _____. Then return all materials in the envelope provided.

It is expected that the information collected will be compiled in an Index which can assist potential participants in locating your program. If course announcements, brochures, or a copy of the syllabus are available, we would appreciate receiving a copy for our files.

We look forward to hearing from you in the near future.

Sincerely,

Clinton L. Shepard, Research Associate

College of Education
Academic Faculty of Science-Mathematics Education

____/_____

WATER QUALITY CONTROL EDUCATION COURSES QUESTIONNAIRE

Directions:

Every attempt is being made to provide correct and up-to-date information regarding professional development opportunities for water quality control personnel.

Your help by completing one form for each course, workshop, seminar, or conference for which you are supplying information will be appreciated. (Duplicate this form as necessary). If you do not feel you can adequately respond to this instrument, please forward it to the appropriate individual or department within your organization.

It is expected that the information collected will be compiled in an Index which can assist potential participants in locating your program. Please fill out this form by supplying the information requested or by placing a check (✓) next to the item which BEST describes your response.

Please return this questionnaire in the enclosed envelope by February 29, 1980, or as soon as you can. Thank you for your cooperation in this project.

COURSE TITLE:_____

1. Is this course applicable for personnel involved in wastewater treatment? ____Yes ____No

2. Which of the following terms BEST describes the format of this course?
   ____Conference
   ____Seminar
   ____Workshop
   ____Short Course
   ____Other(Please specify)
   _____

3. How many times a year is this course offered? _____

4. What is the duration of this course? (i.e. 1 day, 2-3 days, 1 week, etc.) _____

5. What is the number of contact hours between the instructor(s) and participants? _____

6. Is this course primarily designed for:
   ____Updating
   ____Upgrading
   ____Certification

7. What is the average number of participants per course session? _____participants

8. Does your state require certification for any Water Treatment Plant personnel? ____Yes ____No

   If Yes, which personnel?_____

9. Does your state require certification for any Wastewater Treatment Plant personnel? ____Yes ____No

   If Yes, which personnel?_____

10. Is this course approved for certification? ____Yes ____No

    If Yes which association(s)/agency provides accreditation? _____

11. Does this course offer Continuing Education Units to participants? ____Yes ____No

    If Yes, how many? _____C.E.U.'s

12. Is there a cost for this course to the participant? ____Yes ____No

    If Yes, does it apply to: ____Tuition, ____Materials, ____Other

13. Are scholarships available to participants? ____Yes ____No

    If Yes, who provides them?_____

    What are the requirements for scholarship eligibility?_____

14. Are U.S. EPA developed materials used in this course? ____Yes ____No

15. Are course materials available to persons other than course participants? ____Yes ____No

16. Please provide complete reference information for the text/materials/manuals used for this course.

AUTHOR	TITLE	PUBLISHER	DATE
1.			
2.			
3.			

3.

17. Is a formal evaluation of content, materials, and instruction conducted for this course? ____Yes ____No

If Yes, please explain_____

_____

18. Which of the following BEST describes the emphasis of this course?(Check only one)

____Treatment technology - biological
____Treatment technology - physical-chemical
____Treatment technology - advanced
____Equipment operation
____Equipment maintenance
____Equipment evaluation/inspection
____Water Quality - inorganic analysis
____Water Quality - organic analysis
____Water Quality - surveillance/monitoring
____Laboratory procedures
____Basic math/statistics
____Basic engineering principles
____Management Skills - employee relations
____Management Skills - communications
____Management Skills - public participation
____Legislation/Policies
____General Ecology
____Safety
____Environmental Impact Analysis
____Others(Please specify)_____

_____

19. Which of the following instructional methods are used in this course?(Check all that apply)
For each item checked please indicate the percentage of time devoted to that method.

	(Percentage)
____Lecture	_____
____Lecture/Discussion	_____
____Demonstration	_____
____Role playing/Simulation	_____
____Field work(Involvement)	_____
____Field work(Observation)	_____
____Audio-visuals	_____
____Self-study lab	_____
____Programmed learning	_____
____Computer-assisted instruction	_____
____Other(Please specify)	_____

_____

4.

20. From what sector of the profession do you attract the most participants?

____Administrators
____Biologists
____Chemists
____Engineers
____Microbiologists
____Technicians/Operators
____Treatment Plant Supervisor
____Other(Please specify)

_____

21. Which of the following are normally limitations for participants of this course?(Check all that apply)

(✓)		(PLEASE SPECIFY)
	Number of enrollees	
	Education/Experience	
	Geographical location	
	Occupation	
	Professional Membership	
	Employment Classification	
	Physical Ability	
	Other	
	Other	

22. What is the organizational structure of the course sponsor?

____Governmental Agency
____Sales, Manufacturing, or Consulting Firm
____Other Private Business
____Professional Organization
____Degree-granting Institution
____Other(Please specify)

_____

5.

23. PLEASE supply the following information about the OFFICIAL contact for additional course information.

Name(Individual and/or Department)

Address

City State ZIP

Phone

END OF QUESTIONNAIRE

THANK YOU FOR YOUR COOPERATION

PLEASE RETURN QUESTIONNAIRE IN THE ENCLOSED ENVELOPE BY FEBRUARY 29, 1980, OR AS SOON AS YOU CAN.

Return to:

Clinton L. Shepard, Research Associate
EPA Information Dissemination Project
The Ohio State University
1200 Chambers Road
Columbus, Ohio 43212

APPENDIX C

COVER LETTER

AND

WATER QUALITY CONTROL PERSONNEL QUESTIONNAIRE

OSU

The Ohio State University

EPA Information Dissemination Project
Room 209
1200 Chambers Road
Columbus, Ohio 43212
Phone 614 422-6717

February 4, 1980

TO: Director, Wastewater Treatment Operations

The Ohio State University has undertaken a pilot project in relation to the water quality control profession. This project will assess the professional responsibilities of water quality control personnel within the six state area comprised of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

This project has come about as a result of a recognized unequal distribution of identified training opportunities and enrollments. The purpose here is to determine training programs which would be most beneficial to professional growth. Your help is requested.

Your facility was selected at random from all municipal facilities within the designated study area. To assure confidentiality of responses, only grouped data will be reported. The identification number on each questionnaire will only be used to insure completeness of the sample.

Two questionnaires are enclosed in this packet. One questionnaire (yellow copy) is to be completed by the supervisor of the wastewater treatment operations for your municipality. Please select at random an operator/technician at the wastewater treatment facility for your municipality to complete the second questionnaire(green copy).

Each person should complete their questionnaire as soon as possible and return it in the postage-paid envelope provided. Return of the completed questionnaire indicates your willingness to participate in the study.

Please return your questionnaire by February 29, 1980, or as soon as you can.

Thank you for your cooperation.

Sincerely,

Clinton L. Shepard, Research Associate
EPA Information Dissemination Project
The Ohio State University
1200 Chambers Road
Columbus, Ohio 43212

College of Education
Academic Faculty of Science-Mathematics Education

OSU

The Ohio State University

EPA Information
Dissemination Project
Room 209
1200 Chambers Road
Columbus, Ohio 43212
Phone 614 422-6717

March 27, 1980

TO: Director, Wastewater Treatment Operations

Several weeks ago you were sent a request to participate in a study to assess the professional responsibilities of water quality control personnel within the six state area of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

Response to date has been good, however, a check of our records indicates that we have not received a response from your municipality.

We would very much appreciate your input into this study. In the event you may have misplaced the original questionnaires another set is enclosed. The yellow copy should be completed by the supervisor of the wastewater treatment operations for your municipality. Please select at random an operator/technician at the wastewater treatment facility for your municipality to complete the green copy.

Each person should complete their questionnaire as soon as possible and return it in the postage-paid envelope provided. To assure confidentiality of responses only grouped data will be reported. The identification number on each questionnaire is only used to insure completeness of the sample.

If you have already returned your original questionnaires, please accept our thanks for your participation. If not, please complete and return these questionnaires by April 15, 1980, or as soon as you can.

Thank you for your cooperation in this project.

Sincerely,

Clinton L. Shepard

Clinton L. Shepard, Research Associate
EPA Information Dissemination Project
The Ohio State University
1200 Chambers Road
Columbus, Ohio 43212

College of Education
Academic Faculty of Science-Mathematics Education

____/_____

WATER QUALITY CONTROL PERSONNEL QUESTIONNAIRE
(Supervisor)

Directions:

This study is designed to assess the responsibilities of water quality control personnel and determine training opportunities which would be most beneficial to their professional growth.

As supervisor for the wastewater treatment operations for your municipality your help is requested.

Please fill out the questionnaire by supplying the information requested or by placing a check(✓) next to the item which BEST describes your response. To assure confidentiality of your response, only grouped data will be reported.

Please return this questionnaire in the enclosed envelope by April 15, 1980, or as soon as you can. Thank you for your cooperation in this project.

SECTION I - PERSONAL DATA

1. What is the highest level of education you have completed?

_____attended school through grade _____
_____High School - Diploma
_____Associate Degree
_____Bachelors Degree
_____Masters Degree
_____Doctoral Degree

2. Why did you choose this job?

_____Amount of pay
_____Major area of interest
_____Only position available where I desired work
_____Position for which I was best qualified.

3. How long have you been employed at this facility?

_____one year or less
_____2 to 5 years
_____6 to 10 years
_____11 years or more

4. How long have you been employed in your present capacity?

_____one year or less
_____2 to 5 years
_____6 to 10 years
_____11 years or more

5. What is your annual salary range?
   _____$6,000 or less
   _____$6,000 to 12,000
   _____$12,000 to 18,000
   _____$18,000 to 24,000
   _____$24,000 or more

6. Are you a certified wastewater control technician? _____Yes _____No

7. Are you a registered engineer? _____Yes _____No

   If Yes, which area(s)_____

8. Do you belong to a state water quality professional organization? _____Yes _____No

   If Yes, which one(s)_____

SECTION II - PROFESSIONAL DEVELOPMENT

9. During the past year have you participated in any continuing education activities related to your job? _____Yes _____No

   If Yes, was the instruction given on-site? _____Yes _____No

   If Yes, what was the topic area(s)_____

10. Is your participation in continuing education programs mainly for:
    _____updating
    _____upgrading
    _____certification

11. Would you participate in a training course which did not offer continuing education units? _____Yes _____No

12. How familiar are you with training courses directed toward water quality control?
    _____I have no knowledge of such programs
    _____Some familiarity
    _____Knowledgeable about at least one
    _____Knowledgeable about two or more
    _____Thoroughly familiar with more than one

13. Which of the following BEST describes your organization's commitment to employee participation in professional development opportunities?

_____Very high commitment - provides promotion/ salary incentives
_____High commitment - provides tuition reimbursement
_____Moderate commitment - provides release time
_____Low commitment - employee must use own resources

14. How helpful would professional development (training) courses be to you?

_____Extremely helpful
_____Helpful, provides guidance difficult to obtain elsewhere
_____Work experience equally beneficial
_____Work experience more valuable
_____Of no help

15. Which area(s) of training would be most helpful to meet your job responsibilities? (Check all that apply)

_____Treatment Technology - biological
_____Treatment Technology - physical-chemical
_____Treatment Technology - advanced
_____Equipment operation
_____Equipment maintenance
_____Equipment evaluation/inspection
_____Water Quality - inorganic analysis
_____Water Quality - organic analysis
_____Water Quality - surveillance/monitoring
_____Laboratory procedures
_____Basic math/statistics
_____Basic engineering principles
_____Management Skills - employee relations
_____Management Skills - communications
_____Management Skills - public participation
_____Legislation/Policies
_____General Ecology
_____Safety
_____Environmental Impact Analysis
_____Others(Please specify)_____

_____

16. Please rank, in order of importance, the following reasons for participating in professional development courses. (1 for most important - 5 for least important)

_____To obtain advanced degree
_____To perform job better
_____To increase responsibilities
_____To keep up-to-date
_____To meet organization's expectations

SECTION III - FACILITY DATA

1. Does this facility provide Water Treatment? _____Yes _____No

2. Does this facility provide Wastewater Treatment? _____Yes _____No

3. For wastewater, what level of treatment is provided?

_____Primary treatment
_____Secondary treatment
_____Tertiary treatment

4. During what period was this facility constructed?

_____1975 - present
_____1970 - 1974
_____1965 - 1969
_____1960 - 1964
_____1959 or before

5. During what period was the last major upgrading of this facility done?

_____1975 - present
_____1970 - 1974
_____1965 - 1969
_____1960 - 1964
_____1959 or before

6. How does this facility operate with respect to design capacity? _____at, _____above, _____below

7. What is the average daily volume(hydraulic load) of this facility? _____mgd

8. What percentage of the daily flow is devoted to treatment of industrial effluent? _____%

9. How many people are employed at this facility in the following capacities?

_____Operators
_____Technicians
_____Supervisors
_____Managers

10. Does your system provide any in-service training for employees? _____Yes _____No

If Yes, is it available on a regular basis? _____Yes _____No

11. Does your system have an incentive program for employee participation in continuing education or in-service courses?

_____Yes _____No

12. Which of the following administrative patterns BEST describes your system?

_____single municipality system
_____joint facility for two or more communities
_____special district for two or more communities
_____contracting system between communities.

END OF QUESTIONNAIRE

THANK YOU FOR YOUR COOPERATION

PLEASE RETURN QUESTIONNIARE IN THE ENCLOSED ENVELOPE BY APRIL 15, 1980, OR AS SOON AS YOU CAN.

Return to:

Clint L. Shepard, Research Associate
EPA Information Dissemination Project
The Ohio State University
1200 Chambers Road
Columbus, Ohio 43212

APPENDIX D

WATER QUALITY CONTROL EDUCATION PROGRAMS - SPONSORS

ILLINOIS

Illinois EPA
Illinois State University
Sauk Valley College
Rock Valley College
Kaskaskia College
Elgin Community College
Illinois Water Treatment Company
Lincoln Trail College
College of Lake County
Environmental Resources Training Center
College of Du Page
Joliet Jr. College
Northern Illinois University
University of Illinois, Urbana
Black Hawk College
Illinois Central
Kankakee Community College
American Public Works Association
Lake Land College
Lincoln Land Community College
Lewis & Clark Community College
Highland Community College

INDIANA

Indiana Vocational Technical College, Ft. Wayne
Indiana Vocational Technical College, Sellersburg
Indiana Vocational Technical College, South Bend
Indiana State Board of Health
Watcon Incorporated
Rose Hulman Institute
Indiana State University
Indiana University at Kokomo
Butler University
Purdue University

MICHIGAN

General Motors Institute
Schoolcraft College
Monroe County Community College
Alpena Community College

MINNESOTA

Bemidji State University
University of Minnesota

OHIO

Jefferson County Technical Institute
Finnigan Institute
American Society of Metals
Ohio Water Pollution Control Conference
University of Toledo
Wittenberg
MJ Owens Technical College
Cuyahoga Community College
Operator Training Committee of Ohio, Inc.

WISCONSIN

Northeast Wisconsin Technical Institute
Moraine Park Technical Institute
Western Wisconsin Technical Institute
Gateway Technical Institute
Lakeshore Technical Institute
Madison Area Technical Institute

BIBLIOGRAPHY

American City & County; "Don't Underrate Trickling Filters," Vol. 94, No. 6, June 1979, pgs. 59-62.

American City & County; "O & M: The unsubsidized cost of sewage treatment." Vol. 93, No. 12, December 1978, pgs. 35-37.

American Sanitary Engineering Intersociety Board, Inc.; Graduate Education of Sanitary Engineers. Report of Study Conference, June 1960, Cambridge, Massachusetts. pg. 172.

American Society For Engineering Education, Future Directions for Engineering Education. Massachusetts Institute of Technology, 1975, pg. 108.

American Society for Engineering Education, Characteristics of Excellence in Engineering Technology Education, Final Report. 1962, pg. 46.

Anderson, G. W.; "Present and Future Water Pollution Technical Problems," Proceedings of the AMA Congress on Environmental Health Problems, American Medical Association, Chicago, Illinois, 1964, pg. 108.

Anderson, W. C.; "Design for the Operator," Water and Sewage Works, Vol. 126, No. 5, May 1979, pg. 76.

Arvey, R. D.; "Motivational Models and Professional Updating," Maintaining Professional and Technical Competence of the Older Engineer, July 1973, pgs. 142-166.

Association of Boards of Certification, Operating Personnel in Water and Wastewater Utilities; Roles and Responsibilities for Developing a Comprehensive State Water and Wastewater Operator Training Program. ABC Administrative Office, Ames, Iowa. July 1976.

Babbie, E. R.; Survey Research Methods. Wadsworth Publishing Co., Inc., Belmont, California. 1973, pg. 384.

Blair, J. M. and J. K. Pollock; "Training New Operators: One Utility's Approach," American Water Works Association Journal, Vol. 71, No. 7, July 1979, pgs. 369-372.

Baldwin, L. V.; "Media-Based Education Offers University Instruction At the Job Site for Engineers," Professional Engineer, Vol. 49, No. 4, April 1979, pgs. 14-15.

Battelle Columbus Laboratories; Development of a Model Water Quality Area Training Center, Research Program Proposal. January 23, 1979. pg. 34 (Xeroxed communication).

Benjes, H. H. and W. F. Owen; "Really Improve Operation & Maintenance," Water & Wastes Engineering, Vol. 16, No. 10, October 1979, pgs. 21-29.

Beyer, W. H. (Ed); Handbook of Tables for Probability and Statistics Second Edition. The Chemical Rubber Co., Cleveland, Ohio, 1968, pg. 642.

Butman, R. C. and F. C. Frick; "Educational Technology for Teaching." Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 119-127.

Campbell, D. T. and Stanley, J. D.; Experimental and Quasiexperimental Designs for Research. Rand McNally and Co., Chicago, Illinois, 1967, pg. 84.

Carnegie Foundation for the Advancement of Teaching; A Digest of Reports of the Carnegie Commission on Higher Education. McGraw-Hill Book Company, 1974. pg. 399.

Chronicle of Higher Education; "From Land-Grant Colleges to a Cabinet Department: 172 Years of Federal Education Legislation," October 9, 1979, pg. 13.

Clavel, R. L. and A. J. Hollenback; "Training program improves plant performance," Water & Wastes Engineering, Vol. 16, No. 12, December 1979, pgs. 35-37.

The Conservation Foundation; Toward Clean Water: A Guide to Citizen Action. Washington, D.C., 1976, pg. 328.

Cooley, R. A. and G. Wandesforde-Smith (Eds); Congress and the Environment. University of Washington Press, Seattle, Washington, 1970, pg. 277.

Council on Environmental Quality; Environmental Quality - 1970. U.S. Government Printing Office, Washington, D.C., 1970, pg. 326.

Council on Environmental Quality; Environmental Quality: The Fifth Annual Report. U.S. Government Printing Office, Washington, D.C., December 1974, pg. 597.

Council on Environmental Quality; Environmental Quality: Eighth Annual Report. U.S. Government Printing Office, Washington, D.C., December 1977, pg. 445.

Council on the Continuing Education Unit; The Continuing Education Unit: Criteria and Guidelines. Silver Spring, Maryland. April 1979, pg. 38.

Davies, L. E.; "Design of Jobs," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 234-246.

DeLong, E. K.; "Environmentalism in our Age," Ecolibrium, Vol. 8, No. 1, Winter 1979, pgs. 17-21. Shell Oil Company, Houston, Texas.

Dirksen, R. E.; Relevant Learnings for the Industrial Manufacturing Operative, A Dissertation. The Ohio State University, 1969.

Donaldson, G. W.; Profile of the "new" Director of Outdoor/ Conservation Education. A Study of the Personal, Academic and Professional Characteristics of Administrators of Federally-funded Outdoor/Conservation Education Programs. Northern Illinois University, April 1969, pg. 33.

Dubin, S. S.; "Defining Obsolescence and Updating," Maintaining Professional and Technical Competence of the Older Engineer, July 1973, pgs. 1-12.

Dubin, S. S.; H. Shelton and J. McConnel (Eds); Maintaining Professional and Technical Competence of the Older Engineer. American Society for Engineering Education, Conference Report, South Berwick, Maine, July 1973.

Dunbar, G. A. and D. S. Sloan; "New facilities serve dual community role." Water & Wastes Engineering, Vol. 17, No. 3, March 1980, pgs. 16-19.

Edwards, L. H.; "Continuing Engineering Education at Texas A&M," Engineering Education, Vol. 69, No. 8, May 1979, pgs. 815-817.

Engel, W. T.; Personal Communication to W. G. Gilbert, Director, NTOTC, February 22, 1980, Charles County Community College, LaPlata, Maryland.

Erickson, H. M.; "The Nature of Water Pollution," Proceedings of the AMA Congress on Environmental Health Problems. American Medical Association, Chicago, Illinois, May 1964, pg. 108.

Everts, C. M., Jr.; "Regional Water Pollution Control Resources," Proceedings of the AMA Congress on Environmental Health Problems. American Medical Association, Chicago, Illinois, May 1964, pg. 108.

Ghem, H. W. and J. I. Bregman (Eds); Handbook of Water Resources and Pollution Control. Van Nostrand Reinhold Co., New York, New York. 1976.

Goldstein, I. L.; "Toward Individualized Instructional Systems," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 110-118.

Grover, K.; "Don't Blame the Operator," American City and County, Vol. 94, No. 10, October 1979, pgs. 37-42.

Hadeed, S. J.; "New Directions in certification programs," Journal Water Pollution Control Federation, Vol. 50, No. 5, May 1978, pgs. 822-824.

Haller, E. K.; Personal communication regarding the NETA Region V Clearinghouse Project, November 1979.

Haller, E. K.; Personal communication regarding the NETA Region V Clearinghouse Project, March 1980.

Hanks, E. H., A. D. Tarlock and J. L. Hanks; Environmental Law and Policy: Cases and Materials, Abridged. West Publishing Co., St. Paul, Minnesota, 1975, pg. 713.

Hersch, P.; "Too Many Operators Aren't Getting the Message," Water & Sewage Works, Vol. 126, No. 3, March 1979, Editorial.

Howard, F. S. and Others; "Energy Production Through Sludge/Refuse Pyrolysis," Journal Water Pollution Control Federation, Vol. 51, No. 4, April 1979, pgs. 735-740.

Hull, C. H. and N. H. Nie; SPSS Update. McGraw-Hill Book Co., New York, New York, 1979, pg. 238.

Kaufman, H. G.; "A Comparative Analysis of University Versus In-Company Continuing Education for Engineers," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 179-186.

Kaufman, W. J. and Middlebrooks, E. J.; An Evaluation of Sanitary Engineering Education. American Association of Professors in Sanitary Engineering, January 1970, pg. 52.

Kennedy, J. J.; An Introduction to the Design and Analysis of Experiments in Education and Psychology. University Press of America, 1978, pg. 586.

Kerbec, M. J. (Ed); Your Government and The Environment: An Annual Reference: Volume 1. Output Systems Corporation, Arlington, Virginia, 1971.

Kerlinger, F. N.; Foundations of Behavioral Research, Second Edition. Holt, Rinehart & Winston, Inc., New York, New York, 1973, pg. 741.

Kinn, J. M.; "Professional Future Shock: Can Engineers Adapt?" Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 103-109.

Kiraldi, L. and J. L. Burk (Comps); Pollution: A Selected Bibliography of U.S. Government Publications on Air, Water, and Land Pollution 1965 - 1970. Institute of Public Affairs, Western Michigan University, 1971, pg. 78.

Koller, L. L. and J. Matticks; "1977 Market for Water and Wastewater Treatment Equipment," Journal Water Pollution Control Federation, Vol. 51, No. 4, April 1979, pgs. 672-688.

Kosik, L. C.; State Program Descriptions of Wastewater and Drinking Water Operator Training. Office of Manpower Development, U.S. Environmental Protection Agency, Region V, Chicago, Illinois, August 1979, pg. 102.

Landy, F. J.; "The Development of Scales for the Measurement of Updating," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 47-54.

Lisack, J. P.; Manpower Requirements for Pollution Control and Water Resources in Indiana and Related Pollution Control Technology Curriculum. Office of Manpower Studies, Purdue University, Lafayette, Indiana, February 1969, pg. 70.

Lussier, D. and J. Brunk; "EPA's innovative and alternative technology program," Pollution Engineering, Vol. 11, No. 11, November 1979, pgs. 33-36.

McBride, S. E. and J. H. Sherrard; "Wastewater treatment plant operator survey," Journal Water Pollution Control Federation, Vol. 51, No. 12, December 1979, pgs. 2956-2956.

McQuigg, B.; "The Role of Education in Industry," Phi Delta Kappan, Vol. 61, No. 5, January 1980, pgs. 324-325.

Malone, C. D. and P. Swann, "Make Sewage Works Work," The American City and County, June 1978, pgs. 79-81.

Mendenhall, W., L. Ott, and R. L. Scheaffer; Elementary Survey Sampling, Wadsworth Publishing Company, Inc., Belmont, California, 1971.

Micketts, J. P.; "Consultant's Role Expands in Training Plant Personnel," Water & Sewage Works, Vol. 126, No. 3, March 1979, pgs. 76-79.

Miller, D. B.; "Technical Vitality of the Older Engineer in Industry," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 37-46.

Moraine Park Technical Institute, Program Bulletin, Fond du Lac, Wisconsin, 1978.

Morris, A. J.; "Continuing Education & Job Performance: The Causal Connection," Engineering Education, Vol. 69, No. 8, May 1979, pgs. 831-837.

National Institute of Education; An Evaluative Look at Nontraditional Postsecondary Education. U. S. Government Printing Office, Washington, D.C., September 1979, pg. 191.

Neu, B. A.; "Identify and Prevent Confined Space Hazards," Water and Wastes Engineering, Vol. 16, No. 9, September 1979, pg. 90-93, 100.

Nie, N. H., et al; Statistical Package for the Social Sciences, Second Edition. McGraw-Hill Book Co., New York, New York, 1975, pg. 670.

Ockershausen, R. W.; "Process control in plants using aluminum sulfate," A Collection of Reference Articles on Coagulants and Coagulation. Dunn-Donnelley Publishing Corp., New York, New York, pg. 40.

Olympus Research Corporation; Career Education in the Environment: A Handbook. Washington, D.C., pg. 379 (n.d.).

Pipes, W. O.; "Educational Needs and Training Support Water Pollution Control," National Policy Issues: Water Pollution Control. American Society of Civil Engineers Speciality Conference, July 1974, pgs. 12-18.

Podolsky, A. and C. R. Smith; Education Directory, Colleges and Universities, 1977-78. National Center for Education Statistics, U.S. Government Printing Office, Washington, D.C. 1978, pg. 544.

Pollution Engineering, Vol.10, No.12, December 1978. "Environmental Yearbook and Product Reference Guide."

Rand McNally Road Atlas, 55th Edition. Rand McNally and Co., Chicago, Illinois, 1979.

Rohrer, D. M. and others; The Environment Crisis: A Basic Overview of the Problem of Pollution. National Textbook Company, Skokie, Illinois.

Roth, R. E. and others; Environmental Education: Abstracts and Index from Research in Education, 1966-1972. Education Associates, Inc., Worthington, Ohio, 1973, pg. 250.

Rummel, R. J.; Applied Factor Analysis. Northwestern University Press, Evanston, Illinois, 1977, pg. 617.

Schwaller, A. E.; "The Need for Education/Training Programs in Industry," Phi Delta Kappan, Vol. 61, No. 5, January 1980, pgs. 322-323.

Sherrard, J. H. and F. A. Sherrard; "Recruitment and employment of the Water Pollution Control Specialist," Journal Water Pollution Control Federation, Vol. 51, No. 5, May 1979, pgs. 884-889.

Slawsky, D. A. (Ed); ERIC Information Analysis Products, 1975-1977. ERIC Processing and Reference Facility, Bethesda, Maryland, December 1978, pg. 162.

Snarponis, J. E.; "NSPE Established Continuing Professional Development System Approach for Engineers," Professional Engineer, Vol. 49, No. 4, April 1979, pgs. 10-13.

South Carolina Board for Technical and Comperhensive Education; Wastewater Treatment Plant Operator: Student Reference, Volumes I and II.

State Sanitary Engineers; Survey-Study-Compilation of Training Materials for Water Utility Personnel. (Conference Report), Troy, New York, April 1978, pg. 87.

Stoltenberg, D. H.; "Midwestern Wastewater Characteristics," Public Works, January 1980, pgs. 52-53.

Sundstrom, D. W. and H. E. Klei; Wastewater Treatment. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1976, pg. 444.

Swaim, H. W.; "Continuing Education in a Synergistic Work Atmosphere," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 198-215.

Symons, G. W. (Ed); Water and Wastes Engineering. Manual of Practice, Volume 3, Wastewater Systems: Pipes and Piping. Dunn-Donnelley Publishing Corp., New York, New York, 1967, pg. 52.

Teague, R. E.; "Local and Multi-State Water Pollution Control Programs," Proceedings of the AMA Congress on Environmental Health Problems. American Medical Association, Chicago, Illinois, May 1964, pg. 108.

Tebbutt, T. H. Y. Principles of Water Quality Control. Pergamon Press, Ltd., Oxford, England. 1971. pg. 179.

Technological Advancement Centers, Inc.; Guide to Continuing Education: Short Courses for Engineers and Scientists. East Brunswick, New Jersey, March 1979.

Trelease, F. J.; Cases and Materials on Water Law: Resource Use and Environmental Protection, Second Edition. West Publishing Co., St. Paul, Minnesota, 1974, pg. 861.

Udall, S. L.; The Quiet Crisis. Holt, Rinehart, and Winston, New York, New York, 1963, pg. 209.

University of Wisconsin - Extension; 1979-80 Schedule of Programs in Engineering. Madison, Wisconsin.

U. S. Department of Commerce, National Bureau of Standards; Subsidies, Capital Formation, and Technological Change: Municipal Wastewater Treatment Facilities, Volume 1. Charles River Associates, Inc., Cambridge, Massachusetts, July 1977, pg. 140.

U.S. Department of Labor; "Working toward a better Environment," Occupational Outlook Quarterly. U.S. Government Printing Office, Washington, D.C., Spring 1974, pgs. 18-24.

U.S. Environmental Protection Agency; Alternative Waste Management Techniques for Best Practicable Waste Treatment. Office of Water Program Operations, Washington, D.C., pg. 71 (n.d.).

____; Pollution Abatement in the Fruit and Vegetable Industry: Basics of Pollution Control/Case Histories. Research Information Center, Technology Transfer, July 1977, pg. 99.

____; Choosing Optimum Management Strategies: Pollution Control Systems. Technology Transfer Seminar Publications, May 1977, pg. 55.

____; A Report to Congress on Water Pollution Control Manpower Development and Training Activities. Office of Water Programs, U.S. Government Printing Office, Washington, D.C., March 1972.

____; An Instructional Delivery System for Manpower Management: A Report for Water Pollution Control Agencies, Second Edition. Office of Water and Hazardous Materials, April 1979, pg. 192.

____; Water Quality Control Training Courses: October 1978 Through September 1979. NTOTC, Cincinnati, Ohio, 1978.

____; Municipal Sludge Management: EPA Construction Grants Program; An Overview of the Sludge Management Situation. Office of Water Program Operations, Washington, D.C., April 1976, pg. 64.

____; Estimating Staffing for Municipal Wastewater Treatment Facilities. Office of Water Program Operations, Washington, D.C., March 1973.

_____; Manpower Planning for Wastewater Treatment Plants. Office of Water Programs, Washington, D.C.,1972, pg. 212.

_____; Start-up of Municipal Wastewater Treatment Facilities. Office of Water Program Operations, Washington, D.C., December 1973, pg. 92.

_____; Direct Environmental Factors at Municipal Wastewater Treatment Works: Evaluation and Control of Site Aesthetics, Air Pollution, Noise, and Other Operations and Construction Factors. Government Services Administration, Denver, Colorado, January 1976, pg. 104.

_____; A Bachelor of Engineering Technology Curriculum In Water Quality Management: Program Implementation. Division of Manpower and Training, Washington, D.C., pg. 49.

_____; A Bachelor of Engineering Technology Curriculum in Water Quality Management: Course Guides. Division of Manpower and Training, Washington, D.C., pg. 105.

_____; The Supply of Professional Environmental Manpower, Xeroxed Report, May 1979, pg. 14.

_____; Common Environmental Terms. Office of Public Awareness, Washington, D.C., November 1977, pg. 16.

Ulster County Community College; Nutrients: Learner's Guide for a Critical Path in Water Quality Monitoring. Stone Ridge, New York, February 1979, pg. 95.

Water & Sewage Works; "Directory of State and Territorial Water Pollution Control Agencies," Reference Number 1979, December 1979.

Water & Sewage Works; "Water/Wastewater Treatment Plant Operator Qualifications," Reference Number 1979, December 1979, pg. 225.

Water & Sewage Works; "O & M Seminar. Slames Fixed for Poor Operations." Vol.126, No. 10, October 1979, pg. 40-41.

Water & Sewage Works; "Detroit Pursues Training With a Purpose," Vol. 125, No. 12, December 1978, pg. 65.

Water & Wastewater Equipment Manufacturers Association; "Summary of 1977 Amendments to the Clean Water Act," Proceedings of the 6th Annual Industrial Pollution Conference. McLean, Virginia, 1978, pg. 522.

Water Pollution Control Federation; "WPCF and Joint Committee Evaluate Training Aids," Highlights, Vol. 17, No. 3, March 1980, pg.7.

Williams, B. H.; A Sampler On Sampling. J. Wiley & Sons, New York, New York, 1978, pg. 254.

Williams, F. D.; Water Pollution Control Training: The Educational Role of the U. S. Environmental Protection Agency. (Dissertation) University of Cincinnati, 1979, pg. 204.

Williams, L. B.; "ASSE Viewpoint on Continuing Engineering Education," Maintaining Professional and Technical Competence of the Older Engineer. July 1973, pgs. 216-221.

Woloschuk, B. Z., E. P. S. Ottawa, and others: Maritime Operator Training Program for Wastewater Treatment Plant Operators: Glossary of Terms. Department of Environment, Water Pollution Control Directorate, Canada, 1974.

World Health Organization: The Education of Engineers in Environmental Health. Technical Report Series, No. 376, 1967, pg. 26. Geneva, Switzerland.

Wubbena, R. L.; "Operator training: who is responsible?" Journal Water Pollution Control Federation, Vol. 51, No. 5, May 1979, pgs. 890-898.

Yapijakis, C.; "Plan Thoroughly for a Thorough IWS," Water & Wastes Engineering, Vol. 16, No. 5, May 1979, pgs. 73-78.

Zimmerman, M. D.; "Does On-going Study Really Pay?" Machine Design, October 12, 1978. (Reprint).